CHAPTER 4. Environmental Consequences

Introduction

This section discloses the direct, indirect, and cumulative environmental consequences of implementing each of the alternatives in relation to the issues discussed in Chapter 1. The intent of this section is to provide the scientific and analytical basis for the comparison of alternatives. The various alternatives propose actions that would affect the physical. biological, social, and economic components of the human environment. The terms "effects", impacts", and "consequences" are used interchangeably. They can be quantitative or qualitative, shortterm or long-term, adverse or beneficial, real or potential, tangible or intangible, significant or insignificant, unavoidable, irreversible or irretrievable, and can conflict with the actions of other agencies. The effects disclosed have considered the effectiveness of the mitigation measures outlined in Chapter 2. Chapter 3 presented background material, which is often helpful in understanding the effects displayed here.

The effects resulting from each action are described in terms of their context, intensity, and duration. These activities occurring in the same area over time could, under certain circumstances, be incremental and produce cumulative effects. It is necessary to look beyond the defined planning area boundary and to past and future activities to determine the cumulative effects on certain resources. Past, present and foreseeable activities considered as part of the analysis are disclosed in Chapter 3.

Many of the effects discussed in this chapter are complex and not easily quantified. In this light, it should be kept in mind that many of the values presented are modeled predictions of the effects, and that the actual effects may not occur exactly to the degree presented.

This chapter is divided into two sections corresponding to the Key Issue and Other Issues identified in Chapter 1. Each Key Issue and Other Issue is discussed in terms of the consequences of implementing each of the alternatives listed in Chapter 2. This allows the reader who may be only interested in specific issues, to find all the effects related to that issue in one place.

"Important Interactions" is a description of the cause and effect relationships, that is sometimes used to help clarify an issue. It provides a brief background for understanding the discussion that follows.

Environmental Effects include three different types: common to all alternatives, common to groups of alternatives, or specific to individual alternatives. Three types of effects are considered for each situation:

- Direct Effects are caused by the action and occur at the same time and place [40 CFR 1508.8(a)].
- 2. Indirect Effects are caused by the action and are later in time or further removed in distance, but are still reasonably foreseeable [40 CFR 1508.8(b)].
- Cumulative Effects are those that result from the incremental impacts of the action when added to other past, present, and reasonable foreseeable future actions [40 CFR 1508.7].

It is not always possible to distinguish between these three types of effects. The type of effect (Direct, Indirect, or Cumulative) is identified in those situations where it is clearly understood which type is occurring.

This chapter ends with a section titled "Specifically Required Disclosures." These are a number of miscellaneous effects that are required to be disclosed through law or order.

Environmental Consequences Related To Key Issues

Key Issue # 1 – Hatchery Operations

Important Interactions

In order to quantify the impacts upon the water production capacity of the hatchery's wells a numerical ground water flow model was used to generate the data in Table 4.1. This information represents the predicted amount of water available from each well in the shallow aquifer given Icicle Creek and Canal conditions. Well 6 is included because it is also affected by changes to the shallow aquifer. When values are less than 5 feet, water production stops (Karrer, 2001).

Surface/groundwater modeling of the Icicle Creek area indicates that the ground water supply to the production wells in the shallow aquifer would be altered by the diversion of water into the historic stream channel. Table 4.1 depicts ground water levels at various "modeled" stages for each production well. At this time, the hatchery operates annually between Conditions I and II with ground water production at or near 5300 gpm from wells 1-4, and 6-7. Under several Icicle Creek restoration alternatives, hatchery well operation would occur between Conditions II and III. The most critical time would be during the late fall and the early winter months when river conditions will be low and the canal will be dry, Condition III. As indicated by the bold numbers in Table 4.1, based upon a simulated assessment of ground water levels. the hatchery would lose between 510 gpm and 1960 gpm from wells 1-4 and 6-7 given Condition II or III, a 10% to 37% decrease.

Ground water modeling was compared to actual well pumping conditions during the winter of 2001 when the hatchery operated under Condition III, Canal dry, low recharge, and wells pumping. Data collected by the Leavenworth NFH fish production supervisor confirmed the predicted decrease, 28%, in supply of ground water from the hatchery's wells (Table 4.2). Wells 1 and 5 were near capacity, while Wells 4, 6, and 7 were below capacity. Wells 2 and 3 produced no water as of February 28th.

Environmental Consequences

Alternative 1: No Action

Fish Production

The management of Icicle Creek water would continue and would maintain water in the Icicle Canal ensuring the adequate recharging of the area's shallow aquifer. The production of ground water from Wells (1, 2, 3A, 4 and 7) would be sustained. Also Wells 5 and 6, which draw water from the deepwater aquifer, would not be affected (GeoEngineers, 1995). Fish production of 1.625 million Spring Chinook salmon smolts would continue.

Table 4.1 - Modeled Available Drawdown⁶ (Feet), Given 8 Week Modeled River/Canal/Pumping Conditions.

Icicle River/Canal Conditions		1	2	3A	Well	5	6^7	7
I	Canal Wet ¹ Normal Recharge Wells pumping	19. 6	10. 9	1.65	40. 7	NA 2	31. 5	13. 9
п	Canal Dry ³ Normal Recharge Wells pumping	17. 6	8.3	0.75	40. 0	NA 2	30. 7	11. 0
II	Canal Dry ⁴ Low Recharge Wells pumping	10. 3	0.65	-7.9 ⁵	33. 0	NA 2	23. 6	3.35

1 Steady state, High water, Canal and channel at capacity

² Well 5 is not influenced directly by surface water

3 Steady state, low water, Canal full

⁴ Drought conditions, Low water winter flows

⁵ Indicates insufficient head available for pumping beyond 8 weeks; Computer Simulated Test

⁶ Drawdown is defined as the amount of water (feet) in the well above the well's automatic shutoff.

⁷ Well 6 has the capacity to draw water from the deepwater and shallow aguifers.

Table 4.2 - Status of Seven Wells at the Leavenworth NFH Ending February 28th, 2001. Icicle Canal Dry; Low Recharge

Well	Operating	Actual GPM	Designed Capacity (GPM)
1	Yes	1000	1050
2	No	0	580
3	No	0	410
4	Yes	900 (sand)1	1150
5	Yes	1486	1530
6	Yes	941	1300
7	Yes	320	480
	Totals	4647^{2}	6500

¹ Pumping restricted; Well pumps sand when operated unrestricted.

²28.5% decrease

Fish Health

Fish health concerns would remain low; only a few pathogens would be expected in the hatchery's water supply; hence, disease problems may or may not occur.

Adult Capture

The current design and operation of the fish ladder would remain. The ladder's orientation, while upstream, has and would continue to attract sufficient numbers of adult Spring Chinook salmon throughout the duration of the run. Structure No. 5 would continue to halt upstream migration of returning hatchery adults.

Staffing

There would be no increase in staffing.

Alternative 2: Remove All Structures and Natural Flushing of Sediments

Fish Production

As indicated by the surface water/ground water modeling scenarios, (Table 4.1), the diversion of surface water into the historic stream channel would have an effect on the ground water levels of the

production wells. Modeled Conditions II and III would prevail for this alternative until flows exceed 1360 cfs then modeled Condition I would exist. There is the potential for a 28% reduction in ground water supplies during normal to low recharge conditions when the canal is dry. Wells 2, 3A and 7 would be dewatered during extreme low surface water conditions. This reduction in ground water supplies would generate changes in fish production operations. Changes could include a decrease in smolt production by as much as 24%.

Fish Health

Fish health concerns would increase as more fish begin to occupy areas above the hatchery's surface water intake. An increase in the numbers and types of water-borne pathogens and parasites would occur; disease and mortality would occur in fish production ponds. The increase in pathogens would be dependent upon the numbers of fish passing above the water intake and their individual fish health condition at time of passage.

Adult Capture

The eventual removal of all structures would reduce the

capability of the hatchery to attract and capture adequate adult fish to meet production goals required by the Hatcheries Management Plan and Biological Opinion. Returning adult salmon orient themselves by several cues; water flow; smell, and water temperature. The reorientation of the primary flow of water through the historic channel would alter flows in the vicinity of the current fish ladder by 90° (ENSR, 2000). The returning adults would change their orientation in the creek by 900. This change could reduce the effectiveness of the current design by 50%. While a fifty percent reduction in adult capture during an average return year (3335 adults) would not have an effect on fish production, a 50% reduction of adult returns in three of the last 20 return years would have reduced current fish production (See Table 4.3). During an average return year of 3335 adults (USFWS, 1999), current hatchery fish production levels could be maintained.

Staffing

There would be no increase in hatchery staffing for this alternative.

Table 4.3- Adult Capture of Spring Chinook Salmon and Subsequent Fish Production Estimates During Years of Low Adult Returns if Fish Ladder's Effectiveness is Reduced by 50%

Return Year	Actual Return	50% Reduction	# Of Females 60% Females @ 4000 Eggs/per Female	Fish Production (Millions) 90% Egg to Smolt Survival	Reduction in Production	
1994	1019	510	306	1.1	32 %	
1995	462	231	139	0.42	74 %	
1996	1148	574	344	1.24	24 %	

Alternative 3: Remove Most Structures and Mechanical Dredging of Sediments

Fish Production

With the integrity of Structure No. 2 intact as in Alternative 1, water would enter the Icicle Canal when water flow exceeds 1360 cfs (ENSR. 2000). Ground water peak usage occurs annually from December through February when surface water flow is below 1360 cfs. As indicated by the surface water/ground water modeling scenarios (Karrer, 2000) the diversion of surface water into the historic stream channel would have an effect on the ground water levels of the production wells. There is the potential for a 28% reduction in ground water supplies during normal to low recharge conditions if the canal is dry. Wells 2, 3A and 7 would be dewatered during extreme low flow surface water conditions. This reduction in ground water supplies could generate a reduction in fish production by 24%.

Fish Health

Fish health concerns would increase as more fish begin to occupy areas above the hatchery's surface water intake. An increase in the numbers and types of water-borne pathogens and parasites would occur; disease and mortality would occur in fish production ponds. The increase in pathogens would be dependent upon the numbers of fish passing above the water intake and their individual fish health condition at time of passage. However, in this alternative only wild fish would pass above the barriers, hatchery fish would be blocked at Structure No. 5. Thus, the potential for increased numbers of pathogens would be decreased due to a restriction in the numbers of fish that pass the barriers.

Adult Capture

When surface water flow is less than 1360 cfs, flow characteristics in the vicinity of the existing fish ladder would be affected by the redirection

of water into the historic stream channel. However, as water flow in Icicle Creek increases above 1360 cfs, in conjunction with the yearly spring run off and the return of Spring Chinook salmon, water would enter the Icicle Canal and crest the spillway. This water would merge with water in Icicle Creek in the area around the existing fish ladder redirecting flows in a manner similar to current conditions. The capture of returning adults would be maintained at present levels when surface water flow exceeds 1360 cfs. Surface flows of 1360 cfs or above are typical for the majority of the collection season. In addition, a modified Structure No.5 would provide a barrier to upstream passage of returning hatchery adult salmon.

Staffing

Additional personnel would be necessary to monitor fish passage operations at Structure No. 5. Total cost estimate for staffing at Structure No. 5 is \$75,000/year. This covers wages, benefits and administrative costs for staffing two persons at Structure No. 5.

Alternative 5: Fish Ladder Bypassing the Spillway

Fish Production

Similar to the No-Action Alternative, there would be no effect on fish production under this scenario. The water needed for recharging the shallow aquifer (Wells 1-4 and 7) would remain. The Hatchery would operate between Conditions I and II (See Table 4.1), therefore, there would be no decrease in ground water supplies. The provision for a collection and sorting facility for passage of migratory fish would satisfy fish passage requirements and not have a negative impact on the current use and operation of the existing holding ponds. Water required to operate the collection facility would be diverted from the Icicle Canal to provide the necessary attraction for

upstream migrants during nonhatchery fish migration periods.

Fish Health

Concerns about fish health would increase as more fish begin to occupy areas above the hatchery's surface water intake. Disease and mortality would occur in fish production ponds. The increase in pathogens would be dependent upon the numbers of fish passing above the water intake and their individual fish health condition at time of passage. However, in this alternative only wild fish would bypass the barriers, hatchery fish would be trapped in the collection facility and returned to the hatchery holding ponds. Thus, the potential for increased numbers of pathogens would be decreased due to a restriction in the numbers of fish that bypass the barriers.

Adult Capture

Surface water flow characteristics would not be altered; therefore, the effectiveness of the present fish ladder would remain intact.

Staffing

Additional personnel would be necessary to monitor fish passage operations at the holding ponds/fish ladder. Total cost estimate for staffing the mechanical sorter would be \$20,000/year. This covers wages, benefits and administrative costs for staffing one person at this area.

Alternative 6: Modify Headgate and Structure No. 5 Only and Natural Flushing of Sediments

Fish Production

Under this alternative, the majority of the water would flow through the historic channel. The Icicle Canal would be maintained only for flood control purposes; hence, water would not be present in the canal when water flow is less than 1360 cfs (ENSR, 2000). As indicated by the surface water/ground water modeling scenarios (USFS, 2000) the

diversion of surface water into the historic stream channel would affect the ground water levels of the production wells. Modeled Conditions II and III, a dry canal, would prevail for this alternative until flows exceed 1360 cfs then modeled Condition I would exist (See Table 4.1). There is the potential for an overall 28% reduction in ground water supplies during normal to low recharge conditions when the canal is drv. Wells 2, 3A and 7 would be dewatered during extreme low flow surface water conditions. This reduction in ground water supplies would generate changes in fish production operations. Changes could include a decrease in fish (smolt) production by as much as 24%.

Fish Health

Fish health concerns would increase as more fish begin to occupy areas above the hatchery's surface water intake. Disease and mortality would occur in fish production ponds. The increase in pathogens would be dependent upon the numbers of fish passing above the water intake and their individual fish health condition at time of passage. However, in this alternative only wild fish would pass above the barriers, hatchery fish would be blocked at Structure No. 5. Thus, the potential for increased numbers of pathogens would be decreased due to a restriction in the numbers of fish that pass the barriers.

Adult Capture

Increased water flow through the historic streambed would alter the present water flow characteristics in the area near the existing fish ladder. Water flow would approach the ladder at an angle 90° opposite of present flow conditions. Attractant flows would be oriented in the direction of the historic stream channel. While sufficient water containing olfactory cues would be present, high flow through the historic channel would reduce the effectiveness of the attractant water and the ability of the ladder to draw

fish into the hatchery's holding ponds. Adult capture would be reduced during flows periods of less than 1360 cfs by an estimated 50% (See Table 4.3). However, as water flow in Icicle Creek increases above 1360 cfs, in conjunction with the yearly spring run off and the return of Spring Chinook salmon, water would enter the Icicle Canal and crest the spillway. This water would merge with water in Icicle Creek in the area around the existing fish ladder redirecting flows in a manner similar to current conditions. The capture of returning adults would be maintained at present levels when surface water flow exceeds 1360 cfs. Surface flows of 1360 cfs or above are typical for the majority of the collection season.

Staffing

Additional personnel would be necessary to monitor fish passage operations at Structure No. 5. Total cost estimate for staffing at Structure No. 5 is \$75,000/year. This covers wages, benefits and administrative costs for staffing two persons at Structure No. 5.

Alternative 7: Historical Preservation of Structure No. 4 and Natural Flushing and Mechanical Dredging of Sediments

Fish Production

The direct effect would return water into the historic channel to a maximum of 2229 cfs (Sverdrup Civil, 2000). The Icicle Canal would be maintained only for flood control purposes via existing head gate; hence, water would not be present in the canal until spring run off when water flow exceeds 1360 cfs. As indicated by the surface water/ground water modeling scenarios (USFS, 2000) the diversion of surface water into the historic stream channel would affect the ground water levels of the production wells. Modeled Conditions II and III, a dry canal, would prevail for this alternative until flows exceed 1360 cfs then

modeled Condition I would exist (See Table 4.1). There is the potential for a 28% overall reduction in ground water supplies during normal to low recharge conditions when the canal is dry. Wells 2, 3A and 7 would be dewatered during extreme low surface water conditions. This reduction in ground water supplies would generate changes in fish production operations. Changes could include a decrease in smolt production by as much as 24%.

Fish Health

Concerns would increase as more fish begin to occupy areas above the hatchery's surface water intake. Disease and mortality will occur in fish production ponds. The increase in pathogens would be dependent upon the numbers of fish passing above the water intake and their individual fish health condition at time of passage. However, in this alternative both wild and hatchery fish will pass above the barriers. Thus, the potential for increased numbers of pathogens will rise due to the number of fish that pass the barriers.

Adult Capture

Increased water flow through the original streambed would change the present water flow characteristics in the area near the existing fish ladder. Water flow would approach the ladder at an angle (90°) opposite of present flow conditions. Attractant flows would be oriented in the direction of the historic streambed. While sufficient water containing olfactory (smell) cues would be present, the high flow through the historic channel would reduce the effectiveness of the attractant water and the ability of the ladder to draw fish into the holding ponds of the hatchery.

The removal of Structure No. 5 would also reduce adult capture since upstream migration would not be obstructed. While many state and federal facilities operate without upstream barriers, the removal of this barrier and the reorientation of

the primary flow of water in the proximity of the existing fish ladder would reduce the effectiveness of the hatchery's ability to capture adult salmon. Adult capture would be reduced during flow periods of less than 1360 cfs by an estimated 50% (See Table 4.3). However, as water flow in Icicle Creek increases above 1360 cfs, in conjunction with the vearly spring run off and the return of Spring Chinook salmon, water would enter the Icicle Canal and crest the spillway. This water would merge with water in Icicle Creek in the area around the existing fish ladder redirecting flows in a manner similar to current conditions. The capture of returning adults would be maintained at present levels when surface water flow exceeds 1360 cfs.

Staffing
There would be no increase in staffing.

Key Issue # 2 – Stream Dynamics

Important Interactions

Sediment Transport and Stream Restoration

Comparison of the original bed profile elevations shown in the 1939 construction drawings, with cross sections taken as part of this study in 1999, indicated that the majority of areas with sediment deposition average between one and two feet of accumulated sediment depth. Maximum sediment depositions in the order of three feet were found upstream of Structure No. 3 as well as between Structure No. 4 and Structure No. 5. This comparison also showed that there had been some local scouring below the structures built in the creek between 1939 and 1941. This scouring was most noticeable just downstream of Structure No. 2 and Structure No.3, the structures located on the channel's section of steepest gradient. This pattern appeared to be consistent with what one would expect to find in a channel with added flow obstructions. Suspended sediment would deposit upstream of the newly created obstructions and the existing bed would be scoured by the clear water flow below the obstruction.

Data collected for the historic reach by Washington Trout and the Department of Ecology estimated sediment depths to vary from roughly 0.0 feet to 6.0 feet. However, the overall average depth was approximately 1.26 feet with a median depth of approximately 1.0 foot (Lorang et al. 2000). The deeper deposits of sediment are likely attributable to local anomalies such as sand bars or deposits in holes that may have occurred naturally prior to construction of the hatchery. This same study measured existing sediment deposits of up to nearly 10 feet at the Carpenter Hole below the hatchery. Though the canal and spillway may have altered sediment transport after their construction, Carpenter Hole should now be in equilibrium after having continually been exposed to the natural scouring and depositional patterns of Icicle Creek (such as sediment from the 1994 fires, the 8-mile landslide, and the 1999 Icicle landslide). Localized deposition such as this should be expected to occur naturally and fluctuate seasonally as part of the channel's natural equilibrium condition. The survey drawings used for estimation of the historic creek bed would have included naturally occurring deposits such as these as part of the existing streambed. Current probing of sediment depths to the substrate would likely not differentiate between these pre-existing deposits and subsequent deposits resulting from construction and operation of the hatchery structures.

While the presence and magnitude of pre-existing sediment deposits has not been conclusively established, it has been assumed for the purposes of this study that they exist. The most complete estimate of original streambed conditions available has therefore been

assumed to be the Hatchery construction surveys shown on the original drawings. Full stream restoration would be considered accomplished once streambed elevations have been returned to near those recorded for the pre-existing topography of the historic channel. This would allow for seasonal scour and fill of sediment typically found in natural riverine environments.

Environmental Consequences

Alternative 1: No-action

Sediment Transport and Stream Restoration

Flow regimes would not be altered under this alternative. The majority of flow and associated sediment would continue to flow through the canal. Sediment transport issues would not be expected to change. Sediment would continue to accumulate in the historic channel, developing more wetlands that would eventually evolve into uplands.

Because additional flow would not be redirected down the historic channel, no stream restoration would be expected. Continued operation of the head gate in its current manner would maintain the wetland habitat that has developed through the historic channel reach between Structure No. 2 and Structure No. 5.

There would be no change in meander of Icicle Creek below the canal spillway because of this alternative. Therefore there would be no change in risk of flooding for floodplain developments located on the right bank of the channel downstream of the spillway.

Alternative 2: Remove All Structures and Natural Flushing of Sediments

Sediment Transport and Stream Restoration Sediment transport modeling (ENSR, 2000) for Alternative 2 was in two stages. During the first stage, it was assumed that the headgate at Structure No. 2 would be left wide open. Flow estimated by a representative hydrograph compiled from the 1-year, 5-year, and 10-year hydrographs was allowed to naturally split between the historic channel and the canal. Results were calculated for intervals of one, five, and ten years of operation. During this period, the area of greatest scour lowered the thalweg depth by only 9-1/2 inches just downstream of Structure No. 2. Over ninety percent of this scour was shown to occur during the first year of operation. Other areas showed more gradual erosion of up to nearly 7-3/4 inches during the simulated 10 years of the first stage.

The second stage of the model took the resulting thalweg elevation from first stage, assumed that the headgate was completely removed, assumed that all flow was redirected back down the historic channel, and subjected it to the same representative hydrograph for 10 years. Results from this second stage of flushing once again indicated that the greatest area of scour would occur just downstream of the existing location of Structure No. 2, and the scour depth would not exceed much more than 9-1/2 inches. The streambed response after 5 and 10 years of flushing under the simulated second stage conditions showed trends quite similar to the response seen during the first stage. As one would expect, the erosion rate closely tracked the hydrograph. Perhaps more unexpected was the lack of change in erosion rates once the headgate structure was removed.

After twenty years of simulated flushing flow through the channel,

the maximum total depth of scour was predicted to not exceed more than 19 inches. Perhaps more importantly, deposition of this scoured material downstream was not shown to occur in any large quantities. Therefore, for the purpose of regulating the scour of accumulated sediment deposits over some extended time period there does not appear to be a need to use the headgate structure to control flow through the historic channel. Since the presence of the headgate operating fully open was not shown to greatly alter the rate at which erosion would occur, it would appear that maintenance of the structure during the first stage of flushing may not be necessary. Since the headgate structure would not be required for any lengthy period of controlled flushing, the construction of a temporary fishway around the headgate may be unnecessary. Once initial demolition and restoration work has been completed, restriction of flow into the historic channel by the headgate may only be needed to regulate initial flushing of sediment disturbed during the demolition work. The headgate could then be demolished without ever requiring the additional cost of constructing a temporary year round fishway.

From the standpoint of controlling the amount of streamflow down the historic channel, and therefore reducing the risk of localized flooding if the meander loop (Appendix A, Area Map) below the canal/channel confluence is cut off, the headgate structure does serve a useful purpose. There is an increased risk of cutting off the meander loop with increased flow volumes in the historic channel. The historic channel sinuosity would be re-established for this low gradient segment of channel. The natural dynamics of such a low gradient channel are for the channel to move laterally across the floodplain, increase point bars, widen outer bends, and occasionally cut off meander loops. There was less risk of these processes occurring immediately below the spillway

when the majority of flow passed through the canal given the direction of flow over the spillway and the stabilization work added to the left outer bank immediately downstream. With more flow in the historic channel there is greater probability that the meander loop could be cut off. The headgate structure provides the ability to monitor and control the amount of flow in the historic channel. The possibility would exist to cut off the flow through the historic channel if flooding were to begin.

In the long-term the risk of the meander loop being cut off is greater in this alternative with the headgate removed and unregulated flows down the historic channel. Headcutting could become active when flood flows overtop and flow over the meander bend between Structures No. 4 and 5. Overtopping and overland flow across the meander loop is estimated to occur at a water surface elevation of 1124 feet which corresponds to a discharge of about 2600 cfs (essentially the annual flood). As mentioned in Chapter 3, the rate of head cut migration is related to the magnitude of flow in the overflow channel, type of channel substrate, and moisture content of the stream bank soil (Leopold et al. 1992). Given the variability of these factors, predicting the rate and extent of headcut migration is not currently possible. However, the chance of cutting the meander loop by headcut migration may be rather small during smaller flood events such as the annual flood. With increasing magnitude and power of flood events, the possibility would increase. There is a grade control structure at the upstream end of the overflow channel that may serve to prevent capture and redirection of the channel over the meander loop in the event of flooding and headcut migration. However, being at the upstream end of the loop, this structure would not prevent headcut formation or migration in the downstream portion of the loop. This alternative incorporates

instream structures as mitigation measures to prevent overtopping of the meander loop and headcutting migration (see Chapter 2: Design Criteria and Mitigations Common to all Action Alternatives). If mitigation measures were not incorporated into this alternative there would be an increased risk of flooding on federal and private property. Once the meander loop is cut-off and water flows through it, access to private property within the meander loop would be limited, approximately 0.26 miles of Icicle Creek below the hatchery would be de-watered, and the hatchery's adult return ladder would be isolated from Icicle Creek.

Alternative 3: Remove Most Structures and Mechanical Dredging of Sediments

Sediment Transport and Stream Restoration

The maximum amount of water passed through the historic channel would be controlled by the rehabilitated headgate so as to prevent overtopping of the bridge at Structure No. 5. This maximum flow down the historic channel was estimated to be approximately 2,600 cfs. Local scour protection of the stream bed around the remaining diffusion dam at Structure No. 2 would need to be provided for flows this high. Flow splits between the channel and canal indicate that the total flow coming down Icicle Creek required to achieve such a flow in the historic channel would need to equal a flood flow with approximate recurrence interval of 100 years (ENSR, 2000). Actual headgate operations could be controlled so as to limit the scouring potential of this alternative by diverting additional flow down the canal. As was discussed for Alternative 2. sediment depositions were shown to be greatest between Structure No. 2 and Structure No. 3. This accumulated sediment, as well as all sediment under 2600 cfs flow level, would be mechanically dredged from the channel during the initial demolition process. Subsequent flows through the channel would

flush a minor amount of disturbed sediment from the channel. These subsequent moderated flow volumes would maintain the dredged channel shape and configuration. However, the majority of sediment removal would have been accomplished during the dredging process. Material flushed downstream of the Hatchery would not accumulate within the lower Icicle Creek channel (ENSR, 2000). Without the ability to direct all flood flows through the historic channel, an artificial equilibrium would be established within the channel with slightly higher stored sediment levels than would be desired for a fully restored stream channel (Alternative 2). Because flow through the historic channel would remain regulated by the headgate structure, downstream impacts due to sediment transport should be expected to be minimal. With regulated flow held to, or less than, 2600 cfs, there would be a very low risk of overtopping and flow over the meander loop. Consequently there would be a lower risk of channel migration and cut off of the downstream meander loop because of the limit on flow through the headgate and the fact that the headgate would be a permanent fixture acting as a flow control. This would minimize the risk of flow levels that would overtop the bank and cut off the meander loop between Structures No. 4 and 5. This alternative incorporates instream structures as mitigation measures to prevent overtopping of the meander loop and headcutting migration (see Chapter 2: Design Criteria and Mitigations Common to all Action Alternatives). If mitigation measures were not incorporated into this alternative there would be an increased risk of flooding on federal and private property. Also, flow in the historic channel may not enter the pool below the spillway but travel through the meander cutoff channel and re-enter the main creek channel approximately 0.26 miles below the spillway pool, increasing the length of creek affected by a split in flow. Low water effects to

aquatic species and their habitat would occur either in the 0.26 mile section below the spillway pool or in the historic channel and cutoff channel depending on how the Structure 2 headgate is operated and the total flow entering the project area.

Alternative 5: Fish Ladder Bypassing the Spillway

Sediment Transport and Stream Restoration

Alternative 5 would not alter the existing flow patterns through the Hatchery property so no change in sediment transport should be expected. There would be no change in risk of downstream channel migration caused by a shift in flow volume pattern. Fish passage would not be provided through the historic channel and its habitat would not be restored to a more riverine nature.

Alternative 6: Modify Headgate and Structure No. 5 Only and Natural Flushing of Sediments

Sediment Transport and Stream Restoration

Under this alternative the maximum flow down the historic channel was estimated to be approximately 2.090 cfs. Local scour protection of the streambed around the Structure No. 2 diffusion dam would be needed for flows this high. Flow splits between the channel and canal indicate that the total flow coming down Icicle Creek required to achieve such a flow in the historic channel would need to equal a flood flow with approximate recurrence interval of 100 years (ENSR, 2000). With a large amount of the flow being diverted down the canal, this alternative would have limited scouring potential to naturally flush all of the accumulated sediment from the historic channel. Material flushed downstream of the Hatchery would not accumulate within the lower Icicle Creek channel (ENSR, 2000).

Because flow through the historic channel would remain regulated by the headgate structure, downstream impacts due to sediment transport should be expected to be minimal. There would be a lower risk of downstream channel migration given the ability to regulate the flow split at the headgate. This would minimize the risk of flow levels that would overtop the bank and cut off the meander loop between Structures No. 4 and 5. This alternative incorporates instream structures as mitigation measures to prevent overtopping of the meander loop and headcutting migration (see Chapter 2: Design Criteria and Mitigations Common to all Action Alternatives). If mitigation measures were not incorporated into this alternative there would be an increased risk of flooding on federal and private property. Also, flow in the historic channel may not enter the pool below the spillway but travel through the meander cutoff channel and re-enter the main creek channel approximately 0.26 miles below the spillway pool. Low water effects to aquatic species and their habitat would occur either in the 0.26 mile section below the spillway pool or in the historic channel and cutoff channel depending on how the Structure 2 headgate is operated and the total flow entering the project area, increasing the length of creek affected by a split in flow.

Alternative 7: Historical Preservation of Structure No. 4 and Natural Flushing and Mechanical Dredging of Sediments

Sediment Transport and Stream Restoration

The maximum flow down the historic channel is limited by the threat of overtopping the pedestrian bridge at Structure No. 4, a flow of approximately 2,229 cfs. Flow splits between the channel and canal indicate that the total flow coming down Icicle Creek required to achieve such a flow in the historic channel would need to equal a flood flow with approximate recurrence

interval of 10 to 20 years (ENSR, 2000). With a large amount of the flow being diverted down the canal, this alternative would have limited scouring potential to naturally flush all of the accumulated sediment from the historic channel. Sediment depositions are greatest between Structure No. 2 and Structure No. 3. This accumulated sediment, as well as sediment between Structure No. 4 and Structure No. 5, would be mechanically dredged from the channel during the initial demolition process. Subsequent flows through the channel would flush a minor amount of disturbed sediment from the channel. However the majority of sediment removal would have been accomplished during the dredging process. Material flushed downstream of the hatchery would not accumulate within the lower Icicle Creek channel (ENSR, 2000). Without the ability to direct all flood flows through the historic channel, an artificial equilibrium would be established within the channel with slightly higher sediment levels than would be desired for a fully restored stream channel.

Because flow through the historic channel would remain regulated by the headgate structure, downstream impacts due to sediment transport should be expected to be minimal. There remains some risk for downstream channel migration or cut off of the meander loop but this risk is low given the limit on flow volume in the historic channel because of Structure No. 4, and the ability to control split of flow volume at the headgate. This alternative incorporates instream structures as mitigation measures to prevent overtopping of the meander loop and headcutting migration (see Chapter 2: Design Criteria and Mitigations Common to all Action Alternatives). If mitigation measures were not incorporated into this alternative there would be an increased risk of flooding on federal and private property. Also, flow in the historic channel may not enter the pool below the spillway but travel through the meander cutoff channel

and re-enter the main creek channel approximately 0.26 miles below the spillway pool. Low water effects to aquatic species and their habitat would occur either in the 0.26 mile section below the spillway pool or in the historic channel and cutoff channel depending on how the Structure 2 headgate is operated and the total flow entering the project area, increasing the length of creek affected by a split in flow. Additionally, access to private property would be limited.

Key Issue # 3 – Tribal Fishery

Environmental Consequences

Alternative 1: No Action
No change from the current
operating strategy would occur. The
water flow characteristics at the
spillway pool would not change from
the current situation, resulting in no
change to the current tribal fishery.

Alternative 2: Removal of all Structures and Natural Flushing of Sediments

Alternative No. 2 involves the eventual removal of all structures and the discontinued use of the canal. With most, if not all of the Icicle Creek flow diverted into the historic channel, there would be less attraction flow coming from the spillway and existing fish ladder. The currents in the vicinity of the fish ladder would be redirected 90 degrees (ENSR, 2000). Instead of being parallel to the majority of flow, the hatchery's fish ladder would now be on the outside bank of a horseshoe bend in the stream flow (Sverdrup 2000). This redirection of river flows can be expected to lower the attractiveness of the existing fishway entrance (Sverdrup 2000) and alter the orientation and holding patterns of adult salmon in the area of the tribal fishery. It would change the characteristics of the water flow in the tribal fishery from a pool to a flow-through situation. The holding

patterns and behavior of chinook salmon in this area currently allow tribal fishers to use traditional dipnets and hook-and-line to capture fish. Dipnets would no longer be an effective means to capture fish.

The removal of Structure No. 5 further impacts the tribal fishery since upstream migration would not be obstructed, reducing the length of time fish would be available to the fishery. The combination of removal of the fish barrier with the reorientation of water flow in the area of the tribal fishery would reduce the quality of the fishery, especially when using traditional methods.

Alternative 3: Remove Most Structures and Mechanical Dredging of Sediments

In Alternative 3, Structure No. 2 would be modified to allow for fish passage. Structure No. 5 would be modified with a seasonal fish barrier. All other structures would be removed from the historic river channel. When river flows are below 1360 cfs, all Icicle Creek flow would be diverted into the historic channel and the flow would be split when river flows are greater than 1360 cfs. With most of the Icicle Creek flow diverted into the historic channel there would be less attraction flow moving from the spillway and fish ladder (Sverdrup, 2000). This redirection of river flows could be expected to alter the holding patterns and orientation of adult salmon in the area of the tribal fishery. However, as river flows increase above 1360 cfs, water in the canal would crest the spillway (ENSR, 2000). Water cresting the spillway would merge with water in the historic channel in the area around the existing spillway similar to the no-action alternative. Based on the average year hydrograph for Icicle Creek (ENSR, 2000) the river flows would regularly exceed 1360 cfs during spring run-off in the months of May and June. The tribal fishery extends from the beginning of May into July. Under this alternative, Structure No. 2 remains as a flow control structure, and

would be operated to provide greater flows through the canal throughout the duration of the fishery. Therefore, the characteristics of the pool and the fishery would be maintained. Traditional fishing methods would remain effective.

In this alternative, Structure No. 5 would be modified with a seasonal "hatchery fish" barrier constructed in the same location. This barrier would provide the necessary blockage of upstream passage to returning hatchery salmon. The presence of a barrier is important in maintaining the current condition of the tribal fishery.

Alternative 5: Construct Spillway Fish Ladder

The impact of this alternative would be similar to the No-Action Alternative. Flow characteristics would not be altered and Structure No. 5 would remain intact providing a barrier to upstream passage through the historic channel.

Alternative 6: Modify Headgate and Structure No. 5 Only and Natural Flushing of Sediments Alternative No. 6 retains all structures, modifying only Structure No. 2 and 5 for fish passage. When river flows are below 1360 cfs, all flow in Icicle Creek would be diverted into the historic channel. With most of the Icicle Creek flow diverted into the historic channel there would be less attraction flow moving from the spillway and fish ladder (Sverdrup 2000). The currents in the vicinity of the fish ladder would be redirected 90 degrees (ENSR, 2000). Instead of being parallel to the majority of flow, the Hatchery's fish ladder would now be on the outside bank of a horseshoe bend in the stream flow (Sverdrup 2000). This redirection of river flows could be expected to lower the attractiveness of the existing fishway entrance (Sverdrup 2000) and alter the orientation and holding patterns of adult salmon in the area of the tribal fishery. However, as Icicle Creek flows

increase above 1360 cfs, water in the canal would crest the spillway (ENSR 2000). Water cresting the spillway would merge with water in the historic channel in the area around the existing spillway similar to the no-action alternative. Based on the average year hydrograph for Icicle Creek (ENSR 2000) the river flows would exceed 1360 cfs during spring runoff in the months of May and June. The tribal fishery extends from the beginning of May into July. Under this alternative, Structure No. 2 remains as a flow control structure and would be operated to provide greater flows through the canal throughout the duration of the fishery. Therefore, the characteristics of the pool and the fishery would be maintained. Traditional fishing methods would remain effective.

Structure No. 5 would be modified with a seasonal fish barrier in the same location. This barrier would provide blockage of upstream passage to returning hatchery salmon. The presence of a barrier is important in maintaining the tribal fishery as it is currently conducted.

Alternative 7: Historical Preservation of Structure No. 4 and Natural Flushing and Mechanical Dredging of Sediments

In Alternative 7 only Structures No. 2 and 4 would remain as potential barriers in the historic channel. Structure No. 2 would serve to maintain the existing canal for overflow (Sverdrup 2000). When river flow is below 1360 cfs, all flow would be diverted into the historic channel. As river flows increase above 1360 cfs, water in the canal would crest the spillway (ENSR, 2000). With most if not all of Icicle Creek flow redirected into the historic channel, there would be less attraction flow coming from the spillway and existing fish ladder. The currents in the vicinity of the fish ladder would be redirected 90 degrees (ENSR, 2000). Instead of being parallel to the majority of flow, the Hatchery's fish ladder

would now be on the outside bank of a horseshoe bend in the stream flow (Sverdrup 2000). This redirection of river flows could be expected to lower the attractiveness of the existing fishway entrance (Sverdrup 2000) and alter the orientation and holding patterns of adult salmon in the area of the tribal fishery. However, with increasing flow above 1360 cfs, water cresting the spillway would merge with water in the original channel in a manner similar to the no action alternative.

The removal of Structure No.5 would reduce the tribal harvest since upstream migration would not be obstructed reducing the length of time chinook salmon would be available to the fishery. Traditional fishing methods would remain effective but not as productive, as fish would be free to continue upstream from the spillway pool.

Key Issue #4 – Threatened And Endangered Fish Species/Other Fish

Important Interactions

Endangered Species Act (ESA) 1973 (as amended)

The goal of the ESA is to protect threatened and endangered species and their habitat. The law protects listed species from "take" defined as harass, harm (injure or kill), pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempts to engage in such actions. Additionally, the law protects the ecosystems upon which listed species depend on. Conservation of candidate (proposed for listing) species is also promoted. Federal agencies must make sure that their actions do not jeopardize the continued existence of listed species. Actions that may affect listed species and/or their habitat are consulted on with and permitted by the National Marine Fisheries Service for marine and anadromous species and the US Fish and Wildlife Service for inland species. ESA

listed species under consideration in this project are: steelhead and their critical habitat (endangered); nonhatchery spring chinook and their critical habitat (endangered); bull trout (threatened); redband rainbow trout (candidate); westslope cutthroat trout (candidate); and Pacific lamprey (candidate).

Fish Passage

One goal of project implementation is to provide long-term, sustainable year-round passage to native fish through LNFH grounds. The method of fish passage that is provided needs to be safe, unimpeded upstream and downstream for all life stages of threatened and endangered fish and other species.

Habitat

The quantity and quality of fish habitat in the historic channel is mainly limited by sediment accumulation. To increase fish habitat, sediment accumulation must be reduced. Different ways to do this include: raising bankfull stage (flow), removing hatchery structures, and achieving a new equilibrium between aggradation and degradation. The historic channel must also consistently transport its sediment load to maintain habitat.

The importance of bankfull flows should not be underestimated. The bankfull stage corresponds to the discharge at which channel maintenance is most effective. The bankfull discharge does the work (formation and maintenance) that results in the average morphological characteristics (dimension, pattern, and profile) of channels under the modern climatic regime (Dunne and Leopold 1978; Rosgen 1996).

Alternative 1: No Action

Fish Passage

In Alternative 1 fish are excluded from the historic channel and upstream fish passage is provided through use of the existing adult return fish ladder and holding ponds. Once fish enter the ladder and holding ponds they are manually sorted, netted and trucked upstream. This alternative would not provide long-term, sustainable yearround passage for all life stages of native fish. The existing fish ladder was designed for adult salmonids returning to LNFH. The ladder was not designed to meet USFWS and NMFS fish passage criteria and does not accommodate all species and life stages year-round. The ladder is not designed for year around, local hydraulic conditions or the characteristic biology of target species. Some adult steelhead. mainly of hatchery origin, and a few bull trout enter the adult ladder each collection season. The ladder is not an effective method in collecting a majority of the steelhead or bull trout migrating up Icicle Creek. During low water conditions in Icicle Creek the entrance to the fish ladder is above the water level of the river and very difficult for fish to access.

In this alternative non-hatchery fish are separated from hatchery stock manually. This action may harass and stress fish. Overcrowding could occur in the back of the ladder or holding ponds, especially during broodstock return from May 1st through July 31st, which would increase fish stress. Stress could also occur during loading, hauling, and releasing fish. Stress plays a major role in the susceptibility of fish to disease. Although some fish diseases are virulent, most are stress related. Stress caused by handling, crowding, hauling, loading, and stocking plus there cumulative effects can be severe and result in immediate or delayed mortality (Piper et al. 1982).

In Alternative 1 fish migration would remain artificially impeded and fish passage assistance would be necessary. Fish migration in this alternative would be delayed or deterred from the time fish enter the spillway pool through entering the ladder and ponds until upstream release. Delaying or deterring migration effects fish in many ways.

A fish's rate of sexual maturity is established by heredity and cannot adjust to delays. Also, maturing fish stop feeding and rely on energy reserves stored in body fat and protein to carry them through migration and spawning. Delaying migration affects spawning timing and causes abnormal energy expenditures which reduces reproductive success and can cause mortality either during migration or on spawning grounds (Powers and Orsborne 1984). Migration delays in Icicle Creek are not solitary but cumulative. Adult salmon and steelhead traveling from the ocean must migrate 497 miles (795 km) and negotiate 7 Columbia River dams and one Wenatchee River dam before entering Icicle Creek. Multiple barriers, especially coupled with habitat disturbance, cause excessive delays in migration and energy expenditure reducing reproductive success and causing direct and indirect mortality.

Alternative 1 only makes provisions for upstream fish passage. Downstream fish passage would occur through the canal and thus, not be provided year-round. Under the current flow regime and operation of the headgate, the canal dries up in late summer and early fall and can dry up again during the winter. The canal routinely dries up for at least 1 month a year and can be dry for up to 4 months a year. Downstream fish passage would not be provided through the headgate at Structure No. 2 as it would be operated as a flow control structure which would be opened only high enough to allow a minimal amount of flow into the historic channel. The headgate opening height needs to be at least 1 foot to allow adult downstream passage. If fish do enter downstream through the headgate into the historic channel during spring collection season, they would become trapped since passage through Structure No. 5 would be blocked and no provisions for upstream passage through the headgate would be provided.

Habitat

In Alternative 1 there would be no changes to the baseline condition of fish habitat on hatchery grounds (see Chapter 3, Issue #4). In the historic channel, the quantity and quality of spawning, pool, and overwintering habitat would remain minimal and rearing habitat would be unaltered in the short-term. In the long-term instream habitat may be lost through the natural succession of wetland gradually becoming upland habitat through continued sediment accumulation and vegetation encroachment.

Alternative 2: Remove All Structures and Natural Flushing of Sediments

Fish Passage

In Alternative 2, safe and unimpeded upstream and downstream fish passage would be provided for all life stages of threatened and endangered fish and other species. Fish passage in this alternative is provided by the complete removal of Structures 2, 3, 4, and 5 and allowing for unrestricted flow in the historic channel. However, in the short-term (10 to 15 years) the headgate portion of Structure No. 2 would be retained for flow control and a vertical slot fishway would provide passage past the structure. Once the headgate is no longer needed for controlled sediment flushing, it and the vertical slot fishway would be completely removed. In the long-term natural stream passage would occur in the historic channel.

Temporarily in Alternative 2, fish passage is provided at the headgate of Structure No. 2 by a vertical slot fishway. The vertical slot fishway would provide fish passage for a wide range of flows which would include the statistically estimated annual drought through annual flood. A vertical slot fishway at this site is beneficial in many ways: (1) it can be designed to meet USFWS and NMFS fish passage criteria; (2) it can be designed for local hydraulic

conditions and the characteristic biology of target species; (3) it is able to self regulate the depth of flow through the fishway and thus, adjust to fluctuating water surface levels; (4) it would expand the range of stream flows that would be passable by both adult and juvenile anadromous and resident species; (5) it is recommended for streams with high sediment loads since its design resists sediment accumulation within the structure; (6) since it is self regulating the structure requires little maintenance; (7) delays in fish migration would be minimal; and (8) trash racks would be incorporated into the design to keep large debris from entering and blocking the fishway entrance. Overall, "a vertical slot fishway, with its self regulation of flow and increased resistance to sediment accumulation, would likely best meet the operational needs of the site" (Sverdrup Civil, Inc. 2000).

The vertical slot fishway would be designed specifically for the target species, threatened bull trout and endangered steelhead. Weaker swimming non-salmonids in Icicle Creek may not be able to take advantage of upstream passage with a vertical slot fishway. In the long-term, fish passage would be unimpeded for all species.

Minimal downstream fish passage is provided by vertical slot fishways. The downstream entrance to the fishway is difficult for a fish to locate because a minimal amount of flow enters it (Weilick and Allison pers. comm.). In the short-term, effective downstream fish passage would be provided year-round either through the headgate into the historic channel or the canal by regulating the headgate opening height. A headgate opening height of 1 foot is required to pass adult salmonids. In the long-term, the entrance to the canal would be blocked and downstream fish passage would occur through the historic channel via natural stream passage.

All non-hatchery fish that inadvertently enter the hatchery's

adult ladder and holding ponds (instead of migrating up through the historic channel) would be manually sorted, trucked upstream, and released. Manual sorting may harass and stress fish. Overcrowding could occur in the back of the ladder or holding ponds, especially during broodstock return from May 1st through July 31st, which would increase fish stress. Stress could also occur during loading, hauling, and releasing fish. Stress plays a major role in the susceptibility of fish to disease. Stress caused by handling, crowding, hauling, loading, and stocking plus there cumulative effects can be severe and result in immediate or delayed mortality (Piper et al. 1982). Additionally, fish migration in this fish passage method would be delayed or deterred from the time fish enter the ladder and ponds until upstream release. Delaying migration affects spawning timing and causes abnormal energy expenditures which reduces reproductive success and can cause mortality either during migration or on spawning grounds (Powers and Orsborne 1984). Migration delays in Icicle Creek are not solitary but cumulative. Adult salmon and steelhead traveling from the ocean must migrate 497 miles (795 km) and negotiate 7 Columbia River dams and one Wenatchee River dam before entering Icicle Creek. Multiple barriers, especially coupled with habitat disturbance, cause excessive delays in migration and energy expenditure reducing reproductive success and causing direct and indirect mortality.

In Alternative 2 sediment in the historic channel is removed through controlled flushing over a 10 to 15 year time span. In the short-term, flushing of sediments would increase downstream turbidity which may affect fish directly and indirectly in several ways. The extent of effects is dependent on stream flow, duration of sediment disturbance, and time of year sediment is released. Potential biological effects of sedimentation to fish include accumulation of particles

on fish gills which inhibits breathing, covering redds and preventing aeration, and trapping emerging fry.

Additionally, stream sedimentation could delay or deter migration. Delaying migration affects spawning timing and causes abnormal energy expenditures which reduces reproductive success and can cause mortality either during migration or on spawning grounds (Powers and Orsborn 1984). Waters carrying high sediment loads are avoided by migrating salmon or migration ceases if such loads are unavoidable (Cordone and Kelley 1961; in Meehan 1991). A similar response was recorded during a radiotelemetry study in Icicle Creek in 1999. In June 1999, a landslide occurred in the watershed on a flanking slope of the draw that descends from Icicle Ridge. The failure was approximately 120 feet wide and 300 feet long with a slide plane that was approximately 10-15 feet below the pre-failure surface (area = 360,000 to 540,000 cubicfeet). The slide began at an elevation of 4800 feet. Consequently, the resulting volume of material delivered to the valley bottom (Icicle Creek) was many times greater than the initial failure (pers. comm. Matt Karrer, USFS). Of six radio-tagged steelhead that were in Icicle Creek during the landslide, two left the Icicle and entered the Wenatchee River and four were never relocated. Of the five spring chinook in the stream during the slide, three moved downstream to the Wenatchee River and two entered the LNFH ladder. Once the turbid Icicle became clear two chinook re-entered Icicle Creek from the Wenatchee River (Cappellini unpublished).

Habitat

Implementation of Alternative 2 would result in a channel with the closest resemblance to pre-hatchery characteristics than any of the project alternatives. The resulting channel would not contain any historic, hatchery structures and would accommodate and receive a similar bankfull discharge as in pre-

hatchery times. Removal of all structures, especially the headgate, would increase the type and size of bedload entering and passing through the historic channel. Implementation of this alternative would bring the channel substrate closer to historic conditions of gravelly sand with scattered boulders. Also, removal of the headgate would allow for increased recruitment of large woody debris from upstream. Consequently, implementation of Alternative 2 would result in the greatest increase in the quantity and quality of fish habitat. Spawning, pool, overwintering, and rearing habitat would be moderately to highly increased.

There would be no long-term downstream effects to fish habitat through implementation of Alternative 2. Potential effects of sedimentation were identified, however ENSR (2000) determined through hydraulic analysis that implementation of any alternatives would have no significant affect on average to sediment transport characteristics in Icicle Creek below the project site or the Wenatchee River. Refer to Chapter 4, Issue #5 for a more thorough discussion on this topic.

Structure removal and modification, in Alternative 2, would disrupt the streambed and banks, increasing sediment input in the short-term. These actions would be mitigated for by thoroughly revegetating all disturbed areas with local, native riparian species.

Alternative 3: Remove Most Structures and Mechanical Dredging of Sediments

Fish Passage

Implementation of Alternative 3 would provide upstream and downstream fish passage for threatened and endangered fish and most other fish species. Fish passage would remain artificially impeded at Structures No. 2 and 5

during spring collection season and passage devices would be used. During the spring collection season from May 1 to July 31, upstream fish passage in Alternative 3 would be provided through V-trap fishways and sorting facilities on the right and left bank of the historic channel at Structure No. 5 and a vertical slot fishway at Structure No. 2. Outside of spring collection season, the Vtraps would be removed and upstream fish passage through Structure No. 5 would be unrestricted. Note that in this alternative only non-hatchery fish would be allowed to migrate upstream. Hatchery fish are returned to the spillway pool. Structures No. 3 and 4 are removed.

During the spring collection season, when V-traps would be in place. upstream fish migration may be delayed and fish may be stressed from overcrowding and sorting at Structure No. 5. Both steelhead and bull trout spawning migrations overlap with spring chinook collection season. Fish would be delayed from the time they enter the holding areas to the time they respond to the activation of the Denil ladder to the time they are released above Structure No. 5. Delaying migration affects spawning timing and causes abnormal energy expenditures which reduces reproductive success and can cause mortality either during migration or on spawning grounds (Powers and Orsborne 1984). Sorting of fish in this alternative would be done mechanically and would cause minimal stress to the fish. Overcrowding could occur in the holding areas which would stress fish. Stress plays a major role in the susceptibility of fish to disease. Severe stress can result in immediate or delayed mortality.

In Alternative 3 (as in Alternative 2) a vertical slot fishway, with its self regulation of flow and increased resistance to sediment accumulation, best meets fish passage operational needs at Structure No. 2. The vertical slot fishway at the headgate

portion of Structure No. 2 would be designed specifically for the target species, threatened bull trout and endangered steelhead. Weaker swimming non-salmonids in Icicle Creek may not be able to take advantage of passage with a vertical slot fishway.

Minimal downstream fish passage is provided by vertical slot fishways. The downstream entrance to the fishway is difficult for a fish to locate because a minimal amount of flow enters it (Weilick and Allison pers. comm.). Effective downstream fish passage would be provided yearround either through the headgate into the historic channel or the canal by regulating the headgate opening height. Fish migrating downstream through the headgate would be able to exit the historic channel and Structure No. 5 through a V-trap picket weir (installed across the channel downstream of Structure No. 5) during spring collection season. The angled nature of the pickets would help guide fish downstream to the openings, thus minimizing the delay in downstream passage while simultaneously thwarting upstream passage. Any small, juvenile fish moving downstream during the period when the pickets are deployed would be expected to either be small enough to pass through the pickets or strong enough swimmers to keep them from being impinged on the picket (Allison pers. comm.). Impingement may cause bruising, descaling, and other fish injuries. Direct mortality would occur if impingement is prolonged, repeated, or occurs at high flows (NMFS 1994). In this alternative the V-trap picket weir would be deployed during spring collection season and thus, spring runoff (high flows). However, the headgate is retained and flows would be controlled to avoid fish impingement. Outside of spring collection season the V-trap picket weir would be removed and downstream passage unhindered.

Although Structures No. 2 and 5 would be routinely cleared of debris

to keep water flow and fish from being blocked, retaining the structures may cause fish passage problems during low flows. At low flows the remaining structure could distribute flow over too wide and area. Water depth could be too low to allow fish to pass over the structures low sill. This effect could only occur during extreme low water years and thus would be very rare.

In this alternative, sediments in the historic channel would be dredged from the current 2620 cfs water surface elevation down to the pre-hatchery channel contours. Dredged sediment would be placed on hatchery grounds above the floodplain minimizing the amount of sediment transported downstream during project implementation.

All non-hatchery fish that inadvertently enter the hatchery's adult ladder and holding ponds instead of migrating up through the historic channel would be manually sorted, trucked upstream, and released. Manual sorting may harass and stress fish. Overcrowding could occur in the back of the ladder or holding ponds, especially during broodstock return from May 1st through July 31st, which would increase fish stress. Stress could also occur during loading, hauling, and releasing fish. Stress plays a major role in the susceptibility of fish to disease. Stress caused by handling, crowding, hauling, loading, and stocking plus there cumulative effects can be severe and result in immediate or delayed mortality (Piper et al. 1982). Additionally, fish migration in this fish passage method would be delayed or deterred from the time fish enter the ladder and ponds until upstream release. Delaying migration affects spawning timing and causes abnormal energy expenditures which reduces reproductive success and can cause mortality either during migration or on spawning grounds (Powers and Orsborne 1984). Migration delays in Icicle Creek are not solitary but cumulative. Adult salmon and

steelhead traveling from the ocean must migrate 497 miles (795 km) and negotiate 7 Columbia River dams and one Wenatchee River dam before entering Icicle Creek. Multiple barriers, especially coupled with habitat disturbance, cause excessive delays in migration and energy expenditure reducing reproductive success and causing direct and indirect mortality.

Habitat

Implementation of Alternative 3 would not return the historical channel to pre-hatchery conditions. The alternative does not allow for the return of the pre-hatchery flow regime in the historical channel since the canal would be maintained and two structures are retained. A new channel equilibrium would be achieved.

After alternative implementation, flows would be concentrated into a single, stable channel that is reduced in dimensions from pre-hatchery size. The quantity and quality of pool, overwintering, and rearing habitat may increase moderately to highly in the short-term from dredging to the pre-hatchery channel contours. In the long-term, the quantity and quality of fish habitat would increase slightly to moderately because of a reduced flow regime, retention of structures, and the potential for reaccumulation of sediments. Spawning habitat would most likely remain minimal due to a substrate composed of sediments and a reduced opportunity for larger substrate recruitment into and transported through the channel.

There would be no long-term downstream effects to fish habitat through implementation of Alternative 3. Potential effects of sedimentation were identified, however ENSR (2000) determined through hydraulic analysis that implementation of any alternatives would have no significant affect on average to sediment transport

characteristics in Icicle Creek below the project site.

Retaining Structures No. 2 and 5 and increasing flows into the historic channel up to a maximum of 2,620 cfs would affect stream banks and riparian vegetation. Flows through the historic channel would be increased substantially from present conditions. The structures were originally designed to accommodate flows of 200 cfs and occasional short-term flows of 1,000 cfs. Higher flows would erode around the remaining structures, increasing sediment input and decreasing bank and channel stability.

Structure removal and modification, in Alternative 3, would disrupt the stream bed and banks, increasing sediment input in the short-term. These actions would be mitigated for by thoroughly revegetating all disturbed areas with local, native riparian species.

Alternative 5: Fish Ladder Bypassing the Spillway

Fish Passage

In Alternative 5 fish are excluded from the historic channel and fish are collected for upstream passage through the use of the existing adult return fish ladder and new fishway. Alternative 5 does not provide longterm, sustainable year-round passage for all life stages of native fish. The existing fish ladder was designed for adult salmonids returning to LNFH. The ladder was not designed to meet USFWS and NMFS fish passage criteria and does not accommodate all species and life stages year-round. The ladder is not designed for year around, local hydraulic conditions or the characteristic biology of target species. Some adult steelhead, mainly of hatchery origin, and a few bull trout enter the adult ladder each collection season. The ladder is not an effective method in collecting a majority of the steelhead or bull trout migrating up Icicle Creek. During low water conditions in Icicle

Creek the entrance to the fish ladder is above the water level of the river and very difficult for fish to access. Once non-hatchery fish enter the ladder they would be mechanically sorted and transferred via a fishway to the middle of the canal. Mechanical sorting and overcrowding in the back of the ladder or in holding areas may stress the fish. Sorting of fish in this alternative would be done mechanically and would cause minimal stress to the fish. Overcrowding could occur in the holding area, especially during peak spring chinook returns, which would stress fish. Both steelhead and bull trout spawning migrations overlap with spring chinook collection season. Stress plays a major role in the susceptibility of fish to disease. Severe stress can result in immediate or delayed mortality. Fish migration would be delayed from the time fish enter the spillway pool to entering the ladder to release into the canal. Delaying migration affects spawning timing and causes abnormal energy expenditures which reduces reproductive success and can cause mortality either during migration or on spawning grounds (Powers and Orsborne

The canal is not a suitable site for vear-round fish release. The canal is typically dry during late summer to early fall and occasionally during the winter. The canal is a trapezoidal channel with no quality fish habitat, specifically pools or highwater refugia. Releasing fish from the fishway into the canal during high flows would result in fish falling below the spillway and potentially repeating the passage process. Fallback rates were high during the 1999-2000 radiotelemetry study in Icicle Creek, ranging from 60 to 75% for steelhead and 100% for spring chinook. Approximately, 20% and 35% of these steelhead and spring chinook, respectively, re-entered the hatchery's ladder and holding ponds (Cappellini unpublished).

Alternative 5, like Alternative 1, only makes provisions for upstream fish passage. Downstream fish passage would occur through the canal and thus, not be provided year-round. Under the current flow regime and operation of the headgate, the canal dries up in late summer and early fall and can dry up again during the winter. The canal routinely dries up for at least 1 month a year and can be dry for up to 4 months a year. Downstream fish passage would not be provided through the headgate at Structure No. 2 as it would be operated as a flow control structure which would be opened only high enough to allow a minimal amount of flow into the historic channel. The headgate opening height needs to be at least one foot to allow adult downstream passage. If fish do enter downstream through the headgate into the historic channel during spring collection season, they would become trapped since passage through Structure No. 5 would be blocked and no provisions for upstream passage through the headgate would be provided.

Habitat

In Alternative 5 (as in Alternative 1) there would be no changes to the baseline condition of fish habitat on hatchery grounds (see Chapter 3, Issue #4). In the historic channel, the quantity and quality of spawning, pool, and overwintering habitat would remain minimal and rearing habitat would be unaltered in the short-term. In the long-term instream habitat may be lost through the natural succession of wetland gradually becoming upland habitat through continued sediment accumulation and vegetation encroachment.

Alternative 6: Modify Headgate and Structure No. 5 Only and Natural Flushing of Sediments

Fish Passage

Implementation of Alternative 6 would provide upstream and downstream fish passage for

threatened and endangered fish and most other fish species. Fish passage would remain artificially impeded (during spring collection season) by retaining structures and passage devices would be used. During the spring collection season from May 1 to July 31, upstream fish passage in Alternative 6 would be provided through V-trap fishways and sorting facilities on the right and left bank of the historic channel at Structure No. 5 and a vertical slot fishway at Structure No. 2. Outside of spring collection season, the Vtraps boards and racks would be removed and upstream fish passage through Structure No. 5 would be unrestricted. Note that in this alternative only non-hatchery fish would be allowed to migrate upstream. Structures No. 3 and 4 are retained.

During the spring collections season, when barrier panels and V-traps would be in place, fish migration may be delayed and fish may be stressed from overcrowding and sorting at Structure No. 5. Both steelhead and bull trout spawning migrations overlap with spring chinook collection season. Fish would be delayed from the time they enter the holding areas to the time they respond to the activation of the Denil ladder to the time they are released above Structure No. 5. Delaying migration affects spawning timing and causes abnormal energy expenditures which reduces reproductive success and can cause mortality either during migration or on spawning grounds (Powers and Orsborne 1984). Sorting of fish in this alternative would be done mechanically and would cause minimal stress to the fish. Overcrowding could occur in the holding areas which would stress fish. Stress plays a major role in the susceptibility of fish to disease. Severe stress can result in immediate or delayed mortality.

In Alternative 6 (as in Alternative 2) a vertical slot fishway, with its self regulation of flow and increased resistance to sediment accumulation,

best meets fish passage operational needs at Structure No. 2. The vertical slot fishway at the headgate portion of Structure No. 2 would be designed specifically for the target species, threatened bull trout and endangered steelhead. Weaker swimming non-salmonids in Icicle Creek may not be able to take advantage of passage with a vertical slot fishway.

Minimal downstream fish passage is provided at Structure No. 2 by vertical slot fishways. The downstream entrance to the fishway is difficult for a fish to locate because a minimal amount of flow enters it (Weilick and Allison pers. comm.). Downstream fish passage would be provided in this alternative yearround either through the headgate into the historic channel or the canal by regulating the headgate opening height. Fish migrating downstream through the headgate would be able to exit the historic channel and Structure No. 5 through a V-trap on the left and right banks during spring collection season. Fish moving in the center of the stream would be blocked by panels in the center eight bays of Structure No. 5. Fish encountering these panels would have to find their way to one of the banks and the downstream passage bays located along them. Since the panels will not provide any guidance to the fish, delay in movement of the fish downstream would be expected to be higher than for Alternative 3. Flows in this alternative would be reduced near the panels because of backwater effects. Thus, delay caused by the panels would be more of a concern than impingement of weaker swimming or tired fish. Any small, juvenile fish moving downstream during the period when the panels are deployed would be expected to either be small enough to pass by the panels or strong enough swimmers to keep them from tiring and being impinged on the panels before they can find the downstream bays (Allison pers. comm.). Impingement may cause bruising, descaling, and other fish injuries.

Direct mortality would occur if impingement is prolonged, repeated, or occurs at high flows (NMFS 1994). In this alternative the panels would be deployed during spring collection season and thus, spring runoff (high flows). However, the headgate is retained and flows would be controlled to avoid fish impingement. Outside of spring collection season the barrier panels V-traps would be removed and downstream passage unhindered.

Although Structures No. 2, 3, 4, and 5 would be routinely cleared of debris to keep water flow and fish from being blocked, retaining the structure may cause fish passage problems during low flows. At low flows the remaining structures could distribute flow over too wide and area. Water depth could be too low to allow fish to pass over the structures low sill.

In this alternative, sediment in the historic channel would be naturally flushed. For the potential effects of short-term turbidity increases on fish and their habitat refer to Alternative 2 above.

All non-hatchery fish that inadvertently enter the hatchery's adult ladder and holding ponds instead of migrating up through the historic channel would be manually sorted, trucked upstream, and released. Manual sorting may harass and stress fish. Overcrowding could occur in the back of the ladder or holding ponds, especially during broodstock return from May 1st through July 31st, which would increase fish stress. Stress could also occur during loading, hauling, and releasing fish. Stress plays a major role in the susceptibility of fish to disease. Stress caused by handling, crowding, hauling, loading, and stocking plus there cumulative effects can be severe and result in immediate or delayed mortality (Piper et al. 1982). Additionally, fish migration in this fish passage method would be delayed or deterred from the time fish enter the ladder and ponds until upstream

release. Delaying migration affects spawning timing and causes abnormal energy expenditures which reduces reproductive success and can cause mortality either during migration or on spawning grounds (Powers and Orsborne 1984). Migration delays in Icicle Creek are not solitary but cumulative. Adult salmon and steelhead traveling from the ocean must migrate 497 miles (795 km) and negotiate 7 Columbia River dams and one Wenatchee River dam before entering Icicle Creek. Multiple barriers, especially coupled with habitat disturbance, cause excessive delays in migration and energy expenditure reducing reproductive success and causing direct and indirect mortality.

Habitat

Implementation of Alternative 6 would not return the historical channel to pre-hatchery conditions. The alternative does not allow for the return of the pre-hatchery flow regime in the historical channel since the canal would be maintained and all structures are retained. A new channel equilibrium would be achieved.

After alternative implementation, flows would be concentrated into a single, stable channel that is reduced in dimensions from pre-hatchery size, the quantity and quality of pool, overwintering, and rearing habitat may increase slightly to moderately. Spawning habitat would most likely remain minimal due to a substrate composed of sediments and a reduced opportunity for larger substrate recruitment into and transported through the channel.

There would be no long-term downstream effects to fish habitat through implementation of Alternative 6. Potential effects of sedimentation were identified, however ENSR (2000) determined through hydraulic analysis that implementation of any alternatives would have no significant affect on average to sediment transport

characteristics in Icicle Creek below the project site.

Retaining all structures and increasing flows into the historic channel up to a maximum of 2,090 cfs would affect stream banks and riparian vegetation. Flows through the historic channel would be increased substantially from present conditions. The structures were built to accommodate 200cfs with an occasional short-term flow of a 1,000cfs. Higher flows would erode around the remaining structure, increasing sediment input and decreasing bank and channel stability. Retaining structures would also limit the type and size of bedload that enters and passes through the historic channel.

Structure removal and modification, in Alternative 6, would disrupt the stream bed and banks, increasing sediment input in the short-term. These action would be mitigated for by thoroughly revegetating all disturbed areas with local, native riparian species.

Alternative 7: Historical Preservation of Structure No. 4 and Natural Flushing and Mechanical Dredging of Sediments

Fish Passage

Implementation of Alternative 7 would provide upstream and downstream fish passage for threatened and endangered fish and most other fish species. Upstream fish passage in Alternative 7 would remain artificially impeded by the remaining structures and passage devices would be used. In this alternative, Structures No. 3, 5, and most of Alternative 2 are removed. Fish would migrate through the historic channel over the low sill of Structure No. 4 and through a vertical slot fishway at the headgate portion of Structure No. 2 to reach upper Icicle Creek. Although Structure No. 4 would be routinely cleared of debris to keep water flow and fish from being blocked,

retaining the structure may cause fish passage problems during low flows. At low flows the remaining structure would distribute flow over too wide and area. Water depth could be too low to allow fish to pass over the structures low sill (Sverdrup Civil, Inc. 2000). This effect could only occur during extreme low water years and thus would be very rare. In this alternative, fish passage would be provided at the headgate with a vertical slot fishway. The effects of this method of fish passage are discussed in Alternative 2 above.

In Alternative 7 (as in Alternative 2) a vertical slot fishway, with its self regulation of flow and increased resistance to sediment accumulation, best meets fish passage operational needs at Structure No. 2. The vertical slot fishway at the headgate portion of Structure No. 2 would be designed specifically for the target species, threatened bull trout and endangered steelhead. Weaker swimming non-salmonids in Icicle Creek may not be able to take advantage of passage with a vertical slot fishway.

Minimal downstream fish passage is provided by vertical slot fishways. The downstream entrance to the fishway is difficult for a fish to locate because a minimal amount of flow enters it (Weilick and Allison pers. comm.). Effective downstream fish passage would be provided in this alternative year-round either through the headgate into the historic channel or the canal by regulating the headgate opening height.

In this alternative, sediments in the historic channel would be naturally flushed and mechanically dredged. Dredging sediments would minimize the amount of sediment transported downstream during project implementation. In the short-term, flushing of sediments would increase downstream turbidity which may affect fish directly and indirectly in several ways. The extent of effects is dependent on stream flow, duration

of sediment disturbance, and time of year sediment is released. Potential biological effects of sedimentation to fish include accumulation of particles on fish gills which inhibits breathing, covering redds and preventing aeration, and trapping emerging fry. Additionally, stream sedimentation could delay or deter migration.

All non-hatchery fish that inadvertently enter the hatchery's adult ladder and holding ponds instead of migrating up through the historic channel would be manually sorted, trucked upstream, and released. Manual sorting may harass and stress fish. Overcrowding could occur in the back of the ladder or holding ponds, especially during broodstock return from May 1st through July 31st, which would increase fish stress. Stress could also occur during loading, hauling, and releasing fish. Stress plays a major role in the susceptibility of fish to disease. Stress caused by handling, crowding, hauling, loading, and stocking plus there cumulative effects can be severe and result in immediate or delayed mortality (Piper et al. 1982). Additionally, fish migration in this fish passage method would be delayed or deterred from the time fish enter the ladder and ponds until upstream release. Delaying migration affects spawning timing and causes abnormal energy expenditures which reduces reproductive success and can cause mortality either during migration or on spawning grounds (Powers and Orsborne 1984). Migration delays in Icicle Creek are not solitary but cumulative. Adult salmon and steelhead traveling from the ocean must migrate 497 miles (795 km) and negotiate 7 Columbia River dams and one Wenatchee River dam before entering Icicle Creek. Multiple barriers, especially coupled with habitat disturbance, cause excessive delays in migration and energy expenditure reducing reproductive success and causing direct and indirect mortality.

Habitat

Implementation of Alternative 7 would not return the historical channel to pre-hatchery conditions. The alternative does not allow for the return of the pre-hatchery flow regime in the historical channel since the canal would be maintained and two structures are retained. A new channel equilibrium would be achieved.

After alternative implementation, flows would be concentrated into a single, stable channel that is reduced in dimensions from pre-hatchery size, the quantity and quality of pool, overwintering, and rearing habitat may increase slightly to moderately. Spawning habitat would most likely remain minimal due to a substrate composed of sediments and a reduced opportunity for larger substrate recruitment into and transported through the channel.

There would be no long-term downstream effects to fish habitat through implementation of Alternative 7. Potential effects of sedimentation were identified, however ENSR (2000) determined through hydraulic analysis that implementation of any alternatives would have no significant affect on average to sediment transport characteristics in Icicle Creek below the project site.

Retaining Structure No. 4 and increasing flows into the historic channel up to a maximum of 2,229 cfs would affect stream banks and riparian vegetation. Flows through the historic channel would be increased substantially from present conditions. Higher flows would erode around the remaining structure, increasing sediment input and decreasing bank and channel stability. Retaining the headgate portion of Structure No. 2 and Structure No. 4 would limit the type and size of bedload that enters and passes through the historic channel.

Structure removal and modification, in Alternative 7, would disrupt the streambed and banks, increasing sediment input in the short-term. These actions would be mitigated for by thoroughly revegetating all disturbed areas with local, native riparian species.

Effects Common to All Alternatives

Fish Habitat Provided once Fish Passage is Provided Upstream from LNFH

Roughly 28 miles of Icicle Creek lies above LNFH's main property. How far fish can migrate up Icicle Creek, after passing through hatchery grounds, remains unknown. There are several potential man-made (2) and natural fish passage barriers (6) in Icicle Creek above the hatchery. In 1999, the Service implemented a radiotelemetry project with the goal of determining how far fish will migrate upstream (Cappellini unpublished). Between 1999 and 2000, a total of 75 salmonids (bull trout, spring chinook, and steelhead) were radio tagged, placed above LNFH, and tracked. None of these fish migrated past the first natural migration obstacle, the "boulder area" at river mile 5.6. The "boulder area" lies approximately 1.5 river miles above the confluence of the canal and historic channel and is a substantial velocity and gradient fish migration obstacle. The radiotelemetry study did not prove the "boulder area" to be a fish migration barrier. However, it does show that the tagged fish did not migrate past this area during the wide range of flow and water temperature conditions present at the time.

For a general overview of instream habitat in upper Icicle Creek above LNFH, refer to the habitat section of Issue #4 in Chapter 3.

The 1.5 mile reach of Icicle Creek between the confluence of the canal and historic channel on LNFH property and the "boulder area" is mostly in private ownership. Private and commercial development is increasing in the area. The reach is affected by naturally occurring low stream flow and irrigation withdrawals which flow in this reach to very low levels during the summer and early fall (WRWSC 1998). Consequently this area is also affected by extreme high and low water temperatures.

The quantity and quality of fish habitat in this 1.5 mile reach is limited by discharge and sedimentation. In general pool habitat comprises less than 20% of available instream habitat (USFWS unpublished). Pools that are present tend to be of moderate to high quality. Overwintering habitat is minimal. The quantity of rearing habitat for juveniles is ample with the quality dependent on flow and temperature (time of the year). No spawning habitat in this reach exists. The potential for spawning habitat is minimal because of the reach's gradient, large substrate size, embeddedness (sedimentation) of substrate, flow, and water temperatures. For a fish to reach spawning habitat in upper Icicle Creek, after it passes LNFH, it would have to swim roughly 5.75 miles and jump one low flow barrier and pass through 3 substantial, flow and gradient migration obstacles (see Chapter 4, Issue #4. Migration Delay, for a discussion on cumulative effects).

In summary, the probability of opening up more than 1.5 miles of fish habitat in Icicle Creek above LNFH through implementation of alternatives is unlikely. Fish that migrate upstream of LNFH would most likely be limited to the reach below river mile 5.6 where a formidable migration obstacle exists. Many factors affect the quantity and quality of fish habitat in this reach. The only fish habitat of consequences is juvenile rearing habitat. Spawning habitat is not present, overwintering habitat is minimal, and pool habitat is low.

Key Issue #5 – Water Quality/Sediment

Important Interactions

Implementation of each alternative would release a different amount of sediment into the downstream reaches of Icicle Creek. The disturbance of stored sediment and transport of suspended sediment would, by definition, increase turbidity levels. Disturbance of anaerobic soils would cause a change in water chemistry. Increases in turbidity and water quality changes in water bodies cause potential concerns for aquatic organisms and stream habitat.

Common Environmental Effects

Although, implementation of Alternatives 2, 3, 6, or 7 would release different amounts of sediment downstream (described below), none would have an effect on sediment transport characteristics in Icicle Creek below the project site. Icicle Creek would have sufficient energy to transport any flushed sediment to the Wenatchee River. This is validated by the HEC-6 sediment transport model which indicated no deposition in the lower Icicle, from the spillway to the confluence with the Wenatchee River (ENSR 2000). Scaling arguments also suggest the likelihood of dramatic siltation is not a significant threat (WA Trout 2000). The amount of material stored in the historic channel is estimated to be three times the annual sediment load of the Upper Icicle Creek Basin (WA Trout 2000). Clearly the Wenatchee River has sufficient stream power to move the average sediment load delivered from the Icicle. More recently, following extreme wildfires in 1994, period of record flood events during the winters of 1995 and 1996, and landslide events of the late 1990's, there has been considerably larger than average sediment delivery to Icicle Creek. There is

every indication that the Wenatchee River has moved this suspended load totally out of the Wenatchee River Subbasin. However, localized aggradation and degradation may occur. It should also be remembered that any sediment flushed as a result of alternative implementation does not represent a chronic sediment source. Because of this, it is likely that any localized aggradation would be temporary in nature (maximum of 10 years following flushing). Localized sedimentation and erosion occurs naturally, even in channels whose sediment transport is in equilibrium.

Acute and sublethal effects of suspended sediment on fish species are variable. The ability of coho fingerlings to capture prey was reported to be reduced at suspended sediment concentrations of 300-400 mg/l (equivalent to ppm), while mortality occurs at concentrations greater than 20,000 mg/l (MacDonald et al. 1991). Others have reported mortality of underyearling salmonids at concentrations of 1,200 mg/l (Nelson et al. 1991).

In a worst case scenario, if all of the sediment is flushed in one year (estimated at 1,164,072 cubic feet), by flows greater than 1000 cfs, suspended sediment would increase by 106 ppm (Emmett 1998). As a lower bound consider that sediment transport modeling estimates an average thalweg scour between the headgate and the confluence with the canal of .17 feet during a one year flow event (ENSR 2000). Again average sediment depth throughout the historic channel is estimated to be 1.3 feet. For purposes of setting a lower boundary on suspended sediment increases assume the same flows flushing .17 feet (13%) of the sediment in one year. In this case suspended sediment would increase by 14 ppm. For a middle estimate of suspended sediment increase, assume a thalweg scour of .32 feet, which corresponds to a ten year flow event. In this case, suspended sediment would increase by 26 ppm.

Suspended sediment data collected in Icicle Creek by the Washington Dept. of Ecology suggest that for flows below 2500 cfs, suspended sediment concentrations are generally well below 25mg/l (ENSR 2000). Given that in the worst case scenario, suspended sediment as result of flushing would only increase by approximately 106 ppm, implementation of action alternatives are not likely to affect fish populations.

In Alternatives 2, 3, 6, 7 anaerobic soils would be disturbed and recirculated either by flushing or dredging. The release of hydrogen sulfide through flushing and or dredging sediments may affect water quality. The concentration of hydrogen sulfide in the anaerobic soils is unknown. Therefore, the degree of effects, if any, from the release of hydrogen sulfide cannot be determined. However, it is known how to mitigate and reduce potential effects. In general, when hydrogen sulfide is released, the surrounding water is temporarily depleted of oxygen to satisfy the biological oxygen demand of the environment. As oxygen levels decrease, the reduction oxidation potential decreases and the oxidation state of many metal ions and nutrient compounds changes. All reactions tend to reverse as oxygen levels are replenished from the atmosphere and biological processes. Additionally, oxygen may combine with hydrogen sulfide and form sulfuric acid, which could lower the waters pH. The extent of these effects depends on water temperature, flow, turbidity, and channel geometry (Dunne and Leopold, 1978). All of the potential effects can be mitigated for or reduced by increasing flows of cooler water when flushing or after dredging. Another potential concern of disturbing accumulated sediments in the historic channel is the potential release of contaminants. Four contaminants experts from the USFWS and the WA State Department of Ecology were

the release of contaminants through project implementation is not a concern because there are no sources of contaminants upstream of the project area (Cappellini pers. comm.).

Alternative 1: No Action
Implementation of Alternative 1
would have no effect on the stored
sediment in the historic channel and

sediment in the historic channel and therefore would not cause an increase in turbidity levels or a change in water quality.

Alternative 2: Remove All Structures and Natural Flushing of Sediments

In Alternative 2, accumulated sediments are removed through natural flushing. No dredging would occur. In this alternative an increase in flow combined with removal of all structures would result in sediment removal on average of 0.4 feet throughout the channel. approximately 26% of the stored sediments, over a ten year period (maximum 1 ten year flood). However, Alternative 2 is the only alternative in the long-term that allows for the possibility of complete removal of all accumulated sediment since all structures are removed and flows are unrestricted. Flows increased to flush sediment may erode streambanks, especially between Structures No. 4 and 5, downstream of Structure No. 5, and near the existing fish ladder. Some sediments may deposit on the east bank of the historic channel near its confluence with the main channel.

Effects to water chemistry through flushing of accumulated sediments are not likely to occur. Flushing of sediments would occur during high flows when water is cooler.

Increased flows would dilute the concentration of hydrogen sulfide that is released. Colder water contains more oxygen reducing the likelihood of oxygen depletion.

Alternative 3: Remove Most Structures and Mechanical Dredging of Sediments

In Alternative 3 stored sediments in the historic channel would be dredged from the current 2620 cfs water surface elevation down to the pre-hatchery channel contours. Dredging would remove an estimated 76% of the accumulated sediment. The dredged sediment would be stored on hatchery grounds above the floodplain. Storing sediments in this manner would greatly limit the amount of sediment re-entering the creek. Once dredging is complete and stream flow enters the channel. some remaining sediment would flush downstream. Also, retaining Structures No. 2 and 5 and increasing stream flows into the historic channel up to a maximum of 2620 cfs would affect stream banks. Higher flows would erode around the remaining structures, increasing sediment input.

Effects to water chemistry through the dredging of sediments is unlikely. The historic channel would be dewatered before dredging occurs. Thus, the sediment would be recirculated with air not water. Atmospheric effects of hydrogen sulfide release are unlikely because of dilution. However, individuals working in the immediate area would take preventative measures to exposure. Some sediments may be flushed once flows are returned to the historic channel. Flushing of sediments would occur during high flows when water is cooler. Increased flows would dilute the concentration of hydrogen sulfide that is released. Colder water contains more oxygen reducing the likelihood of oxygen depletion.

Alternative 5: Fish Ladder Bypassing the Spillway

Implementation of Alternative 5, as in Alternative 1, would have no effect on the stored sediment in the historic channel and therefore would not cause an increase in turbidity levels or a change in water quality.

Alternative 6: Modify Headgate and Structure No. 5 Only and Natural Flushing of Sediments

In Alternative 6 accumulated sediments in the historic channel would be removed by natural flushing. Approximately, 0.1 to 0.8 feet of sediment throughout the historic channel would be flushed through flow increases and up to 4 feet of sediment would be scoured from around structures. Natural flushing would remove 3 to 26% of the stored sediment.

Effects to water chemistry through flushing of accumulated sediments are not likely to occur. Flushing of sediments would occur during high flows when water is cooler. Increased flows would dilute the concentration of hydrogen sulfide that is released. Colder water contains more oxygen reducing the likelihood of oxygen depletion.

Alternative 7: Historical Preservation of Structure No. 4 and Natural Flushing and Mechanical Dredging of Sediments

In Alternative 7 accumulated sediments in the historic channel would be removed by a combination of flushing and dredging. Stored sediment between Structures No. 2 and 3 and between Structures No. 4 and 5 would be dredged down to the 1938 longitudinal profile. The dredged sediment would be stored on hatchery grounds above the floodplain. Storing sediments in this manner would greatly limit the amount of sediment re-entering the creek. Part of the remaining sediment would be naturally flushed. Implementation of Alternative 7 would remove an estimated 53 to 70% of the accumulated sediment in the historic channel.

Effects to water chemistry through the dredging of sediments is unlikely. The historic channel would be dewatered before dredging occurs. Thus, the sediments would be recirculated with

air not water. Atmospheric effects of hydrogen sulfide release are unlikely because of dilution. However, individuals working in the immediate area would take preventative measure to exposure. Some sediments would be flushed once flows are returned to the historic channel. Flushing of sediments would occur during high flows when water is cooler. Increased flows would dilute the concentration of hydrogen sulfide that is released. Colder water contains more oxygen reducing the likelihood of oxygen depletion.

Key Issue # 6 – Historic Values

Important Interactions

LNFH was listed in the National Register of Historic Places on July 27, 1998. The designation is based on the Hatchery's association with the efforts of the Bureau of Reclamation to mitigate for the loss of salmon due to the construction of the Grand Coulee Dam. The Icicle Creek structures, canal, and spillway are distinctive features of the overall design of the LNFH and are within the Area of Potential Effects of the stream restoration project.

Effects Common to all Alternatives

The effects to historic properties differs substantially among the alternatives. Each of the alternatives is assessed for their affect on the use, function, design, and materials of the in-stream structures identified as Structures No.2, 3, 4, the canal, and spillway. However, the mitigation strategy for each of the alternatives is fairly similar. For alternatives that require modifying existing structures the design would be reviewed by SHPO to ensure that the changes have the least impact to original materials and are in conformance with the Secretary of the Interior's Standards for the Treatment of Historic Properties

(Appendix C). Structure No. 5 has received critical alterations and is not considered eligible on the National Register.

For alternatives that require the removal of the dams, mitigation would be stipulated in a Memorandum of Agreement (MOA) with the Washington State Historic Preservation Office (SHPO) and the Advisory Council on Historic Preservation (Council). The North Central Washington Museum is an interested party in this process and would be invited to participate in the MOA. The mitigation strategy for historic properties for the Icicle Creek Restoration Project would include: recording, interpreting, and managing the historic properties (where they remain). Recordation through photographs and measured drawings is the accepted method for mitigating the loss of historic properties. Interpreting the recorded images would provide the public with a link to the original design of the hatchery. And, a management plan would provide guidance for maintaining the remaining structures. A monitor would be on-site during the demolition or structure altering activities within the Icicle Creek channel associated with the stream restoration project. The monitor would photograph the structures as they are exposed or modified. The monitor would also, if possible, collect pieces of the structures that could be used in an interpretive context.

Alternative 1. No Action

This alternative would not change the use, function, design, setting, or materials of the historic structures in Icicle Creek. However, these structures would continue to deteriorate over time, particularly during flood events.

Alternative 2. Remove all Structures and Natural Flushing of Sediments

The effect of this alternative would change the 1939 Hatchery Plan by

taking water out of the canal, and removing all the in-stream structures in the historic channel. The canal, headgate, and Structures are contributing landscape features of the Hatchery complex. Alternative 2 would dramatically change the use, function, design, setting, and materials of the historic properties associated with the 1939 Hatchery Plan. Therefore, in accordance with 36 CFR 800, mitigation for the loss of historic property would be implemented by an MOA. The MOA, developed through consultation, would include recording and interpreting the features that would be lost as suggested in Alternative 2. A management plan would be developed for the remaining hatchery features.

Alternative 3. Removal of Most Historic Channel Structures

This alternative would restore the historic channel while partially retaining the headgate. The headgate would be modified to allow fish passage with the addition of a fish ladder. Structures No. 3 and 4 would be removed. Structure No. 5 would be modified so that it could operate as a seasonal barrier that would be able to pass non-hatchery fish and sediment, but block hatchery fish.

Modifying the headgate with a fish ladder would conform to the Secretary of the Interior's Standards for the Treatment of Historic Properties (36 CFR part 68). Changing the use of the canal would cause a change in the character of the property which contributes to its historical importance. Removing Structures No. 3 and 4 from the Icicle Creek channel would cause a loss of historic materials. Alternative 3 would adversely effect the integrity of historic properties associated with the 1939 Hatchery plan. Therefore, the mitigation strategy would be implemented by an MOA and include recording and interpreting

the features that would be lost as suggested in Alternative 3. A management plan would be developed for the remaining hatchery features.

Alternative 5. Construction of a Fish Ladder Bypassing The Canal Spillway, Use The Canal as Passage

Alternative 5 would not substantially alter the flow of water through the canal. The headgate would be retained and would serve its original purpose of controlling flows in the historic channel. All of the instream structures would remain.

Modifying the headgate with a fish ladder should conform to the Secretary of the Interior's Standards for the Treatment of Historic Properties (36 CFR part 68). Alternative 5 would not affect the integrity or character of the existing structures in the historic channel. This alternative would not affect historic properties.

Alternative 6. Modify Headgate and Structure No. 5 and Natural Flushing of Sediments

Under Alternative 6 the headgate would be retained and would serve its original purpose controlling flows in the historic channel. For this alternative, the headgate would be modified by building a fish ladder around it so that fish could swim upstream and avoid this obstacle. All of the in-stream structures would remain, except Structure No. 5 which would be modified with V-traps and sorting facilities on either side to provide passage to non-hatchery fish.

Modifying the headgate with a fish ladder would conform to the Secretary of the Interior's Standards for the Treatment of Historic Properties (36 CFR part 68). Modification of Structure No. 5 is considered to be a "No Historic Properties Affected" outcome because the dam has received

critical alterations and is not considered eligible to the National Register. This alternative would not affect historic properties.

Alternative 7. Historical Preservation of Structure No. 4 and Natural Flushing and Mechanical Dredging of Sediments

This alternative would restore the historic channel while retaining the complex of structures at Structure No. 4. A combination of natural flushing and dredging would be required to remove sediment from the historic channel.

Modifications would be made to the headgate at Structure No. 2 to allow fish passage, by the addition of a fishway. Instream structures associated with Structures No. 2, 3, and 5 would be removed. While removing Structures No. 2 and 3 an effort would be made to salvage materials that could be used to repair Structure No. 4. The Structure No. 4 complex of structures including the diffusion dam, racks, and egg collecting station seining trough would be retained although modifications to allow passage of near bankfull flows without eroding stream banks around the ends of the structures may be necessary. Modifications might include notching of the concrete diffusion dam base, removing boards and screens, and repairing the rack system so that it is operational. Structure No. 4 is the most complete ensemble of the Icicle Creek channel and conveys the clearest association with the 1939-1940 construction plans.

Modifying the headgate with a fish ladder and modifying Structure No. 4 to allow bankfull flows would conform to the Secretary of the Interior's Standards for the Treatment of Historic Properties (36 CFR part 68). Removing Structures No. 2 and 3 from the Icicle Creek channel would change the use, function, design, setting, and materials of historic properties associated with the 1939 Hatchery plan. However, the loss of these two properties would be somewhat ameliorated by the retention of Structure No. 4.

Therefore, in accordance with 36 CFR 800, mitigation for the loss of historic property would be implemented by an MOA. The MOA, developed through consultation would include recording and interpreting the features that would be lost as suggested in Alternative 7. A management plan would be developed for the remaining hatchery features.

Key Issue #7 – Wetlands

Important Interactions

Wetlands are a unique ecosystem protected by the Clean Water Act (CWA) of 1977. Specifically, Section 404 of the Act establishes a program to regulate the discharge of dredge and fill material into waters of the U.S., including wetlands, through a permit process. Wetlands are being reduced at an alarming rate in the U.S. To reduce this trend, the federal government set a wetland protection goal of "no-net-loss" in structure or function. This same goal is promoted by the State of Washington.

Common Environmental Effects

Implementation of Alternatives 2, 3, 6, and 7 would increase the amount of flow in the historic channel. All of these alternatives would change the hydrologic conditions which allowed for the development of wetlands. Unrestricted stream flow would enter the channel in Alternative 2. Max flows for Alternatives 3, 6, and 7 are 2,620, 2,090, and 2,229 cfs respectively. Baseline conditions for the historic channel wetland include a flow regime typically less than 200 cfs. Current bankfull flows for the channel were determined to be 1450 cfs (ENSR and Stream Team). During bankfull flow, at least 80% of the 47 individual wetlands are covered by surface water. As flows increase in the historic channel, water surface elevations (WSE), channel widths (W), and flow area (A) increases (Table 4.4).

Table 4.4 - Results of Comparing Maximum Flow Dimensions Along the Channel, per Alternative, to Current Bankfull Conditions 1450 cfs (showing increases)

Alternative	Analysis	WSE (ft)	W (ft)	A (ft ²)	A % increase
3 and 2*	Range	1.72 - 9.78	0 - 204.9	290.8 - 2376.7	154,5 - 567.9
	Median	3.6	64.1	621.3	193.4
6 and 7	Range	1.21 - 6.93	0 - 204.9	197.3 - 1458.9	137 - 402.3
	Median	2.1	23.4	380.4	151.7

^{*}Data unavailable, however, maximum flow and subsequent channel dimensions would be greater than in Alternative 3.

Mitigation for this loss of wetland habitat involves enhancing, preserving or constructing new wetlands of similar function and area (Appendix H. Section D). Within the Hatchery grounds there is the ability to enhance existing wetlands along the historic channel and construct a new wetland at the "return-flow" ditch. Outside the Hatchery grounds, wetlands would be preserved by acquisition of private property and/or conservation easements, on a willing seller basis. These acquisitions would likely not provide the current continuous. quality wetland habitat, but would serve as adequate mitigation.

Alternative 1: No Action

Implementation of Alternative 1 would not change the flow regime in the project area. No structures are removed or modified and no accumulated sediment is flushed or dredged. Therefore, implementation of Alternative 1 would have no effect on baseline conditions in the project area, including the structure and function of wetland habitat. The trend of habitat, within the historic channel, changing through time from riverine to wetland as sediment accumulates and vegetation encroaches, would continue. In the long-term, wetland would gradually become upland habitat through natural succession and existing wetland habitat would be lost.

Alternative 2: Remove All Structures and Natural Flushing of Sediments

Alternative 2 incorporates mitigation measures (see Chapter 2: Actions Common) for wetland effects. Mitigation would strive to achieve a "no-net-loss" of wetland habitat.

Implementation of Alternative 2 would result in a channel with the closest resemblance to pre-hatchery characteristics. The resulting riverine channel would not contain any historic, hatchery structures and would accommodate and receive a

similar bankfull discharge as in prehatchery times. Implementation of Alternative 2 would fully reverse the trend of riverine habitat becoming wetlands.

Discharge in the historic channel would exceed the current bankfull flows of 1450 cfs 2-4 months a year, depending on water year, mainly during the spring and early summer. During this time, all 9.4 acres of existing wetlands would be covered by an average of two to nearly four feet of water. Thus, the wetland vegetation would be submerged during the growing season. Part of this vegetation includes the class C noxious weed reed canary grass. Flooding of the reed canary grass may eradicate this weed from hatchery grounds.

Controlled flushing of sediments, in the short-term, 10 to 15 years, would remove approximately 26% of the accumulated sediments. In the longterm, sediment flushing would be uncontrolled and the balance between degradation and aggradation unhindered. This alternative has the best potential for removing all accumulated sediments without re-accumulating sediment. Removal of sediments in the historic channel would limit the substrate in which wetland plants can grow. Flushing, of accumulated sediments in the historic channel downstream, could potentially result in natural creation of wetlands further downstream in the Wenatchee River Basin as deepwater habitat becomes more shallow and wetland vegetation is established.

During implementation of this alternative, structures would be temporarily modified and/or removed. These actions would disrupt the stream bed and banks, increasing sediment input in the short-term and reducing riparian vegetation. These effects would be mitigated for by thoroughly revegetating all disturbed areas with local, native riparian species.

Impacts to the historic channel, through implementation of Alternative 2 in the long term, would eliminate most of the dimension, structure, and function of current wetlands and riparian vegetation. 0.4 acres of wetland would remain. The critical impact is altering the hydrology of the channel which "is the single most important determinant for the establishment and maintenance of specific types of wetlands and wetland processes" (Mitsch and Gosselink 1986).

Wetland habitat in lower Icicle Creek and the lower Wenatchee River drainages is unique and increasingly threatened by development. Wetland reduction on hatchery grounds would cumulatively add to the past wetland losses and potential future wetland losses in these drainages.

Alternative 3: Remove Most Structures and Mechanical Dredging of Sediments

Alternative 3 incorporates mitigation measures (see Chapter 2: Actions Common) for wetland effects. Mitigation would strive to achieve a "no-net-loss" of wetland habitat.

Implementation of Alternative 3 would not return the historical channel to pre-hatchery conditions. The alternative does not allow for the return of the pre-hatchery flow regime in the historical channel since the canal would be maintained and two structures are retained. A new channel equilibrium would be achieved. In the short-term. sediment in the historic channel would be dredged from the current 2620 cfs water surface elevation down to the pre-hatchery channel contours. Dredging would directly eliminate all 9.4 acres of wetland currently present. Dredging would also limit the substrate in which wetland plant species may grow. In the long-term, a reduced flow regime and retention of structures would allow for the potential of sediments to re-accumulate. A

potential for a minimal amount of wetland habitat, mainly riparian, to rebuild in the channel exists.

Discharge in the historic channel would exceed the current bankfull flows of 1450 cfs 2-4 months a year, depending on water year, mainly during the spring and early summer. During this time, all 9.4 acres of land where wetlands currently exist would be covered by an average of two to nearly four feet of water. Thus, the area where wetland vegetation once grew would be submerged during the growing season. Part of this vegetation includes the class C noxious weed reed canary grass. Dredging and/or flooding of the reed canary grass may help with its eradication from hatchery property.

During implementation of this alternative structures would be temporarily modified and/or removed. These actions would disrupt the stream bed and banks, increasing sediment input in the short-term and reducing riparian vegetation. These effects would be mitigated for by thoroughly revegetating all disturbed areas with local, native riparian species.

Retaining Structures No. 2 and 5 and increasing flows into the historic channel up to a maximum of 2,620 cfs would affect stream banks and riparian vegetation. Higher flows would erode around the remaining structure, increasing sediment input, decreasing bank and channel stability, and potentially reducing nearby wetland habitat.

Impacts to the historic channel, through implementation of Alternative 3, would directly reduce the dimension, structure, and function of wetlands and riparian vegetation. The critical impacts are dredging and altering the flow regime.

Wetland habitat in lower Icicle Creek and the lower Wenatchee River drainages is unique and increasingly threatened by development. Wetland reduction on hatchery grounds would cumulatively add to the past wetland losses and potential future wetland losses in these drainages.

Alternative 5: Fish Ladder Bypassing the Spillway

Implementation of Alternative 5, like Alternative 1, would not change the flow regime in the project area. No structures are removed or modified and no accumulated sediment is flushed or dredged. Therefore, implementation of Alternative 5 would have no effect on the baseline conditions of wetland habitat. The trend of habitat, within the historic channel, changing through time from riverine to wetland as sediment accumulates and vegetation encroaches, would continue. In the long-term, wetland would gradually become upland habitat through natural succession and existing wetland habitat would be lost.

Alternative 6: Modify Headgate and Structure No. 5 Only and Natural Flushing of Sediments

Alternative 6 incorporates mitigation measures (see Chapter 2: Actions Common) for wetland effects. Mitigation would strive to achieve a "no-net-loss" of wetland habitat. Alternative 6 allows for more on-sight mitigation than the other alternatives.

Implementation of Alternative 6 would result in a channel with reduced dimensions from prehatchery conditions. The alternative does not allow for the return of the pre-hatchery flow regime in the historical channel since the canal would be maintained and all structures would remain. A new channel equilibrium would be achieved. 3 to 26% of accumulated sediment would be naturally flushed from the historic channel. Sediment removal and increases in flow would limit the substrate in which wetland plants can grow.

Flushing, of accumulated sediments in the historic channel downstream, in this alternative could potentially result in natural creation of wetlands further downstream in the Wenatchee River Basin as deepwater habitat becomes more shallow and wetland vegetation is established.

Discharge in the historic channel would exceed the current bankfull flows of 1450 cfs 2-4 months a year (depending on water year) mainly during the spring and early summer. During this time, all 9.4 acres of existing wetlands would be covered by an average of two to nearly four feet of water. Thus, the wetland vegetation would be submerged during the growing season. Part of this vegetation includes the class C noxious weed reed canary grass. Flooding of the reed canary grass may help with its eradication from hatchery property.

During implementation of this alternative some structures would be modified. These modifications would disrupt the stream bed and banks, increasing sediment input in the short-term and reducing riparian vegetation. These effects would be mitigated for by thoroughly revegetating all disturbed areas with local, native riparian species.

Retaining all structures and increasing flows into the historic channel up to a maximum of 2,090 cfs would affect stream banks and riparian vegetation. Higher flows would erode around the remaining structure, increasing sediment input, decreasing bank and channel stability, and potentially reducing nearby wetland habitat.

Impacts to the historic channel, through implementation of Alternative 6, would reverse the trend of riverine habitat becoming wetland habitat. Thus, directly reducing the dimension, structure, and function of wetlands and riparian vegetation. In this alternative, approximately 30%, roughly 3 acres, of wetland habitat

mainly near the stream banks would most likely persist. The critical impact is altering the hydrology of the channel which "is the single most important determinant for the establishment and maintenance of specific types of wetlands and wetland processes" (Mitsch and Gosselink 1986).

Wetland habitat in lower Icicle Creek and the lower Wenatchee River drainages is unique and increasingly threatened by development. Wetland reduction on hatchery grounds would cumulatively add to the past wetland losses and potential future wetland losses in these drainages.

Alternative 7: Historical Preservation of Structure No. 4 and Natural Flushing and Mechanical Dredging of Sediments

Alternative 7 incorporates mitigation measures (see Chapter 2: Actions Common) for wetland effects. Mitigation would strive to achieve a "no-net-loss" of wetland habitat.

Implementation of Alternative 7 would result in a channel with reduced dimensions from prehatchery conditions. The alternative does not allow for the return of the pre-hatchery flow regime in the historical channel since the canal would be maintained and 2 structures would remain. A new channel equilibrium would be achieved. 53 to 70% of accumulated sediment would be naturally flushed and dredged from the historic channel. Sediment removal and increases in flow would limit the substrate in which wetland plants can grow.

Flushing, of accumulated sediments in the historic channel downstream, in this alternative could potentially result in natural creation of wetlands further downstream in the Wenatchee River Basin as deepwater habitat becomes more shallow and wetland vegetation is established.

Discharge in the historic channel would exceed the current bankfull flows of 1450 cfs 2-4 months a year (depending on water year) mainly during the spring and early summer. During this time, all 9.4 acres of existing wetlands would be covered by an average of two to nearly four feet of water. Thus, the wetland vegetation would be submerged during the growing season. Part of this vegetation includes the class C noxious weed reed canary grass. Dredging and flooding of reed canary grass may help with its eradication from hatchery property.

During implementation of this alternative some structures would be modified and/or removed. These actions would disrupt the stream bed and banks, increasing sediment input in the short-term and reducing riparian vegetation. These effects would be mitigated for by thoroughly revegetating all disturbed areas with local, native riparian species.

Retaining 2 structures and increasing flows into the historic channel up to a maximum of 2,229 cfs would affect stream banks and riparian vegetation. Higher flows would erode around the remaining structure, increasing sediment input, decreasing bank and channel stability, and potentially reducing nearby wetland habitat.

Impacts to the historic channel, through implementation of Alternative 7, would reverse the trend of riverine habitat becoming wetland habitat. Thus, directly reducing the dimension, structure, and function of wetlands and riparian vegetation. In this alternative there is the potential for a minimal amount (0.4 to 1.0 acre) of the wetland habitat, mainly near the stream banks, to persist. The critical impacts are dredging and altering the hydrology of the channel which "is the single most important determinant for the establishment

and maintenance of specific types of wetlands and wetland processes" (Mitsch and Gosselink 1986).

Wetland habitat in lower Icicle Creek and the lower Wenatchee River drainages is unique and increasingly threatened by development. Wetland reduction on hatchery grounds would cumulatively add to the past wetland losses and potential future wetland losses in these drainages.

Environmental Consequences Related to Other Issues

Issue # 8 – Sport Fishery

Alternatives 1, 3, 4, 5 and 6 provide no additional sport fishery opportunities, as hatchery spring chinook salmon cannot pass beyond the spillway pool. This is the current situation.

Alternatives 2 and 7 would have the potential to extend the existing sport or tribal fishery about one mile along the historic channel on LNFH grounds (within the planning area) during the spring chinook season (since there would be no barriers to them). The expected high demand for this fishery (which can be accessed from the shore) could result in a limited access program on the island. It is estimated that this fishery could provide opportunities for 25 fishers/day over a six-week period. If access to this fishery is open, two or three times that amount of fishers could be expected on weekend days.

Issue # 9 – Aquifer Dynamics

Important Interactions

Icicle Creek traverses a valley filled with glaciofluvial and alluvial sediments. Two aquifers occur in these local sediments that are utilized by the Hatchery through eight commercial wells. Recharge for the aquifer is provided in part by infiltration from the canal and the historic channel. Changes to the stream flow regime of the canal or the historic channel may affect the utilization of the aquifer by the hatchery. The effects displayed here are used to determine the effect on Key Issue #1, Hatchery Operations.

Environmental Consequences

Q. How would alternatives affect the surface water/ground water dynamics and the ability of the hatchery to utilize their well field?

Alternative 1: No Action

Both the historic channel and the canal would be managed as they presently are. Under this alternative, flow of Icicle Creek would continue to be routed down the bypass channel at water surface elevations greater than 1129 feet. Presently, the canal is dewatered during late summer early winter as flows in Icicle Creek fall below this level. The hatchery's needs would be provided by utilizing the well field in much the same way it is now in combination with the river and recycled water. Peak use periods of the well field in December would be limited to less than four weeks (Sverdrup 2000).

Alternative 2: Remove all Structures and Natural Flushing of Sediments

This alternative would remove all of the structures in the historic channel and rely on natural flushing to remove sediment from the channel. After the channel has been restored, the headgate would be removed and the canal would be abandoned with an upstream structure to direct flow down the historic channel. This would result in year round dewatering of the canal.

After eight weeks (maximum duration that wells would be utilized continuously in late summer/early fall) of withdraw under a simulated pumping scenario (see Appendix L for description of simulated conditions and model results), with the canal watered and normal recharge conditions, most of the wells appear to retain sufficient head for continued pumping. The exception is well 3a, which would most likely be dewatered.

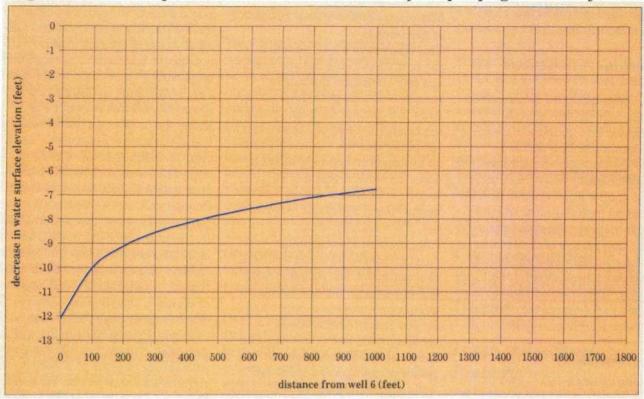
Results are similar for eight weeks of withdraw, normal recharge conditions, and a dewatered canal.

When the canal is dewatered under low recharge conditions, eight weeks of withdraw would likely dewater both well 2 and 3a. Furthermore, well 7 has little available head and appears to dewater as well.

Though it is likely that wells 2, 3a, and 7 would be dewatered under the preceding scenario, if these wells were shut down, the remaining wells (including well 5) would be capable of producing around 5,000 gpm (current groundwater production is 5,300 gpm from wells 1-4 and 6-7). Also, if individual pumping cycles were reduced along with a reduction in the total number of cycles, wells 2, 3a, and 7 may have sufficient head to continue operation.

While some of the southern hatchery wells would likely be dewatered after eight weeks of cycled pumping, it does not appear that surrounding, private, neighboring wells would be affected. Fig. 8 (Appendix L) displays the drawdown for well six while Fig. 1 shows the profile on a north trending line of the cone of depression. As is clear from figure 1, the cone of depression levels out rapidly within approximately 1500 feet from well 6. Private wells to the north of the project area are approximately 1700 feet from the production wells and most are relatively deep >50 feet with sufficient heads to absorb a limited change in static heads (well logs available in analysis file). As a result dewatering of these wells is not expected. Private wells to the west are generally greater than 100 feet deep with sufficient heads to absorb limited reduction in static heads. However, there are a few private wells along Icicle road that are between 50 and 80 feet deep, with about 20 feet of available drawdown. Since individual characteristics of these wells (e.g. pump placement) are unknown, it is difficult to assess the potential effects of a reduction in static water levels.

Figure 1 - Cone of Depression at well 6 after 8 weeks of cycled pumping of Hatchery wells.



Alternative 3: Remove Most Structures and Mechanical Dredging of Sediments

This alternative would remove most of the structures while maintaining the headgate for flow control. Under this alternative, the canal would be watered, although during periods of high water more of the flow would be directed down Icicle Creek. In this case the effect on well operations would be similar to the no action alternative [see Fig. 5, Fig 6, Table 1 and Table 3 (Canal wet, Normal Conditions) in Appendix L for specific details]. During periods of low water in the late fall it is likely that the canal would be dry (similar to current conditions). Under these conditions (canal dry normal recharge), the effects of pumping under a cycled schedule for eight weeks would be the same as displayed in Alternative 2 (see Fig. 7, Fig. 8, Table 1 and Table 3 in Appendix L for specific details).

Alternative 5: Fish Ladder Bypassing Spillway

This alternative would leave all structures in the historic channel and would maintain current operation of the headgate. Effects to the aquifer and production wells would be the same as the no action alternative.

Alternative 6: Modify Headgate and Structure No. 5 and Natural Flushing of Sediments

Under this alternative, the canal would continue to be watered, although during periods of high water more of the flow would be directed down the canal. In this case the effect on well operations would be similar to the no action alternative (see Fig. 5, Fig 6, Table 1 and Table 3 (Canal wet, Normal Conditions) in Appendix L for specific details). During periods of low water in the late fall it is likely that the canal would be dry (similar to current conditions). Under these conditions (canal dry normal recharge), the effects of pumping under a cycled schedule for eight

weeks would be the same as displayed in Alternative 2 (see Fig. 7, Fig. 8, Table 1 and Table 3 in Appendix L for specific details).

Alternative 7: Historical Preservation of Structure No. 4 and Natural Flushing and Mechanical Dredging of Sediments

Under this alternative the headgate would be rehabilitated and used as a flow control structure. This would allow greater diversion of water down the historic channel than is currently taking place. While the canal would remain watered throughout much of the year, with more water diverted down Icicle Creek during late season, it is likely that the canal would be dry for longer periods than it currently is. Under these conditions (canal dry normal recharge), the effects of pumping under a cycled schedule for eight weeks would be the same as displayed in Alternative 2 (see Fig. 7, Fig. 8, Table 1 and Table 3 in Appendix L for specific details).

Issue # 10 – Downstream Improvements

Important Interactions

A stream restoration project beginning immediately downstream of the canal spillway on the left bank of Icicle Creek was completed in 1998. The goals of the project were to protect the hatchery's fish ladder and pollution abatement pond and to restore stream bank stability. A series of eight rock barbs with incorporated wood were keyed into the left bank to redirect flows into the middle of the channel. The rock barbs were designed to function with the majority of streamflow coming through the canal.

Environmental Consequences

Implementation of Alternatives 1 and 5 would have no effect on the downstream restoration project completed in1998. Neither of these alternatives would change the current operation of the headgate and flows in the historic channel would remain minimal.

Alternatives 2, 3, 6, and 7 incorporate measures to mitigate for potential effects to the downstream restoration project. Mitigation actions would maintain the function of the 1998 restoration work and allow it to meet its goals. Therefore, there would be no effect to the restoration area through implementation of any of these alternatives. If mitigation measures were not incorporated into these alternatives, implementation of them would cause the downstream restoration project to not properly function and limit its ability to protect hatchery structures. Alternatives 2, 3, 6, and 7 would increase flows in the historic channel and/or change the amount of flow split between the canal and historic channel, altering the direction and amount of stream flow that enters

the restoration project. The project consists of a series of instream rock barbs and slope stabilization extending 1400 lineal feet from the hatchery's fish ladder downstream. The restoration project was designed to function with the majority of stream flow entering the project area from the canal not the historic channel. The project would not properly function with a redirection of the majority of stream flow. Currently, when flows are increased in the historic channel. stream flow visibly moves directly towards the left bank, in between two of the rock barbs. Erosion and instability of the left stream bank, including effects to the base of the adult ladder, would be imminent and breaching of the LNFH pollution abatement pond potentially may occur if mitigation measures were not undertaken.

Issue # 11 – Endangered, Threatened, And Sensitive (ETS) Plant Species

Effects Common to Alternatives 2, 3, 6 and 7

Direct and Indirect

Under Alternatives 2, 3, 6 and 7, structures would be modified or removed, sediment would be flushed or dredged and stream flow would increase in the historic channel. There are no endangered, threatened and/or sensitive plant species in the planning area and therefore there would be no direct effects on any ETS plant species. If any ETS plants are discovered during implementation of the project, they would be protected from physical disturbance by protective buffers and timing restrictions. The loss of wetland habitat as discussed in Key Issue #7 would indirectly affect two plant species that are dependent on wetland habitat by reducing the potential habitat available for them.

Cicuta bulbifera and Spiranthes diluvialis are dependent on wetland habitat as indicated in Appendix D.

Cumulative

Wetland habitat in the lower Icicle Creek and lower Wenatchee River drainages is fairly unusual and under increasing pressure from development. Development on private lands is impacting the headwaters of Mountain Home stream, the wetlands in the Ski Hill area of Leavenworth, and the wetlands on Icicle Island. Decreasing wetland habitat and thus decreasing potential habitat for the two ETS plant species mentioned above is an indirect but cumulative effect.

Effects Common to Alternatives 1 and 5

Direct, Indirect and Cumulative Effects

Under Alternative 1, the no action alternative, and Alternative 5, flows in the historic channel would remain minimal, no structures would be altered or removed, and no sediment would be removed. Current conditions would continue and there would be no effect on ETS plant species due to their absence in the planning area. The trend of habitat within the historic river channel changing with time from riverine to wetland as sediment accumulates and vegetation encroaches would most likely continue. In the long term, wetlands would gradually become uplands by the process of natural succession and the existing potential habitat of wetland would be

Issue # 12 - Noxious Weeds

Effects Common to Action Alternatives 2, 3, 6, and 7

Heavy equipment required in all alternatives which involve dredging and removal of structures from the historic channel could directly cause the introduction of new noxious weed species if allowed to enter hatchery grounds without cleaning. Seeds of new noxious weed species or plant parts capable of propagating new individual plants can easily be introduced on machinery which has been used in other weed-infested areas prior to arrival at the hatchery. This equipment would need to be cleaned to ensure that it is free of soil, vegetative matter or other debris that could contain seeds prior to entering hatchery grounds.

Given the current weed infestation at the hatchery (see Chapter 3 for a list of the noxious weed present), there is also a problem with increasing the spread of noxious weeds already present. The heavy equipment associated with those alternatives involving the removal of structures from the historic channel and/or dredging (Alternatives 2, 3, 6, 7) would further the spread of weeds if allowed to drive through or operate in weed infestations in the late summer and early fall when seed dispersal is taking place. The heaviest weed infestations are located a distance away from the river channel. Keeping the equipment out of these weedinfested areas would assist with preventing the further spread of noxious weeds within the planning area. Cleaning of equipment would also be required before leaving the hatchery grounds to prevent the further spread of noxious weeds to the adjacent landowners and beyond.

Implementation of the Integrated Weed Management Plan for the Leavenworth National Fish Hatchery (scheduled to begin in 2001) would commence prior to the initiation of activity in the planning area. Control of flower and seed production in the current weed infestation in the planning area is a priority in this plan (Knecht, pers. comm.) and this would likely enhance the mitigation described above to prevent the further spread of noxious weeds by heavy equipment in the planning area.

Disturbed soil resulting from transport or operation of heavy equipment would indirectly affect the spread of noxious weeds by providing available ground for invasion by opportunistic species such as weeds. Planting seeds of desirable plants to fill the available niches and compete with the noxious weeds would likely provide effective mitigation (see references cited in Chapter 2 under discussion of effectiveness of mitigation measures). Seeding immediately following disturbance so that the weeds are not given a chance to take hold would be necessary. In addition, many weed species are known to be intolerant of shade, so planting of trees and shrubs would help to provide more shade and thus, a less favorable environment for weeds.

Alternatives 3 and 7, which entail mechanical dredging and creation of a slag pile could also indirectly enhance the further spread of weeds by providing open fresh soil for invasion by weeds. This slag pile would be seeded to compete with noxious weed seeds that would be transported to the pile by natural agents. The slag pile itself would likely be involved in the spread of weeds if the slag material was piled on top of weeds actively producing flowers and seeds and if the slag material was then used elsewhere as fill. This scenario would be avoided by not disturbing the slag pile for ten years. As the slag pile would not be used for fill in other areas after deposition and would be left undisturbed for a period of 10 years, the slag material would not be involved in the further spread of weeds. The 10 year no-disturbance time period would ensure that the weed seed buried under the slag pile is no longer viable.

Cumulative Effects

The LNFH is adjacent to private land and National Forest land with similar weed problems. The spread of noxious weeds is likely to continue and increase without control measures actively carried out on all lands, public and private. The proximity of the LNFH grounds to the tourist crowds of Leavenworth and the highly popular recreation area of Icicle River with its scenic value, campgrounds, trails, access to the Alpine Lakes Wilderness, mountain biking, and climbing routes makes weed spread even more inevitable with heavy traffic.

The Integrated Weed Management Plan for the Leavenworth National Fish Hatchery (2001) includes the planning area associated with this project and provides for the control and prevention of further weed spread on hatchery grounds. This would reduce the potential for weed spread from the ground disturbance, heavy equipment, and slag pile associated with removal of structures and dredging of the river channel.

Effects of Alternative 1

Weeds would likely continue to spread at their current rate until the Integrated Weed Management Plan for the LNFH (2001) is implemented.

Issue # 13 – Threatened And Endangered Wildlife And Other Wildlife Species And Habitats

Important Interactions

Wildlife species are dependent on several different habitat types that provide forage/prey, shelter/cover, nesting/denning, and water.

Cumulative habitat losses in the lower Icicle Valley have occurred from the development of riparian areas and wetlands, transportation needs (roads and trails), flooding/stream bank erosion, noxious weed encroachment, and the 1994 forest fires.

Activities or operations in the River, Canal or historic channel at the LNFH may cause physical disturbance to several species of wildlife during their nesting, breeding and rearing periods. Many wildlife species utilize wetlands and riparian habitat for parts or all of their home ranges. Disturbance to and loss of wetlands may have an effect on individual wildlife populations. Modifying the historic channel would cause a change in both riparian and wetlands use by wildlife. Currently approximately 20% of the wetlands are midchannel. Over time (50 years), a more natural "ebb and flow" of wetlands habitat may occur as the aging historic channel structures decay and fail, causing a loss of wetland habitat during flooding conditions.

Environmental Consequences

Wildlife species, their habitat, and their uses are diverse and complex. Environmental consequences for each alternative are discussed by individual species or blended into habitat groups.

Threatened and Endangered Wildlife Species and Their Habitat

The hatchery area includes the following threatened and endangered wildlife species and their habitats. These species include gray wolf, grizzly bear, bald eagle and northern spotted owl. Wildlife species and habitats that are not in the hatchery area include designated critical habitat for northern spotted owl, Canada lynx, and marbled murrelet.

Gray Wolf

There have been no confirmed sightings of gray wolves in the planning area. The Icicle River Restoration area does not include any refugia/core habitat due to the high density of motorized roads and adjacent human habitation sites. Habitat is available for wolves and their prey, primarily deer and elk, and to a lesser extent, smaller

mammals including beaver and

Under all alternatives, there would not be any direct effect from disturbance to denning or rendezvous sites for gray wolves, as there are no known denning or rendezvous sites present in the planning area. There would not be any increased human access as a result of any action alternatives. The planning area includes existing high road densities and high use trails. There are no additional road building activities associated with any alternative. Road densities will not be increased and refugia/core habitat will not be decreased. There would not be any interrelated/interdependent effect

from roads or trails to gray wolves.

Alternatives 2, 3, 6 and 7 would result in a loss of wetland habitat in the historic channel. This loss would have an indirect effect on the grav wolf from the reduction of available habitat for deer fawning and foraging. Alternatives 2 and 6 would allow the wetland to be naturally scoured by increased water flow, Alternative 3 would require dredging the historic channel to reduce downstream sedimentation. and Alternative 7 would have a combination of natural scour from increased flows with some dredging to minimize downstream sedimentation. These four alternatives would impact deer by reducing or eliminating the existing wetlands in the historic channel. Currently, deer fawn in the wetlands and feed on riparian vegetation within the historic channel, this would not change under Alternatives 1 or 5. Alternatives 1 and 5 would have the least effect to gray wolf of all the alternatives.

Mitigation measures would implement timing restrictions during the fawning period during the first year. In addition, riparian habitat within 100 feet of the stream will be retained or improved. Noxious weeds will be reduced in operations areas. The loss of

wetlands would be mitigated both on-site and off-site, through habitat improvement and conservation easements. The wetland mitigations would also reduce cumulative effects from increased development in the Icicle Valley.

The Alternatives 2, 3, 4, 6 and 7 would have a "May affect, not likely to adversely affect" to gray wolves. Alternatives 1 and 5 would have a "no effect" to wolves.

Grizzly Bear

The Icicle Restoration area does not include any core habitat for Bear Management Units (BMUs), due to the high density of motorized roads and adjacent human habitation sites. No grizzly bears have been observed in the planning area, but due to the species is wide-ranging nature, the Peshastin and Icicle BMUs are considered occupied in the larger scale. The planning area lies within the North Cascades Grizzly Bear Ecosystem recovery area. The hatchery grounds have food sources for grizzly bear including fawning habitat, spring emergence vegetation, and spawning salmon. Black bear occur in the planning area, feeding on ripe berries and salmon carcasses. Black bears have become habituated to compost, garbage and pet food, due to the amount of homes in this area.

There would not be any increased human access as a result of any action alternative. The planning area includes existing high road densities and high use trails. There are no additional road building activities associated with any alternative. Road densities would not be increased and core habitat would not be decreased. The Icicle and Peshastin BMUs would not be affected. There would not be any cumulative effects from roads or trails on grizzly bears.

Under all alternatives, there would not be any direct effect from disturbance to grizzly bear denning or foraging sites, as there are no known grizzly bear denning or

foraging areas within or adjacent to the planning area. There would be no disturbance to black bear denning, but foraging habitat will be disrupted with the loss of wetlands. Action alternatives would cause a benefit for black bears, by increasing foraging opportunities with salmon moving upstream from the hatchery area.

Alternatives 2, 3, 6 and 7 would result in a loss of wetland habitat in the historic channel. This loss would have an indirect effect on grizzly bears from the reduction of available habitat for deer fawning and foraging, as well as a decrease in habitat available for bear hiding cover. Alternatives 2 and 6 would allow the wetland to be naturally scoured by increased water flow, Alternative 3 would require dredging the historic channel to reduce downstream sedimentation, and Alternative 7 would have a combination of natural scour from increased flows with some dredging to minimize downstream sedimentation. These four alternatives would impact deer by reducing or eliminating the existing wetlands in the historic channel. Currently, deer fawn in the wetlands and feed on riparian vegetation within the historic channel, this would not change under Alternatives 1 or 5. Alternatives 1 and 5 would have the least negative effect to grizzly bears, of all the alternatives.

Under all action alternatives, salmon passage above the hatchery would improve forage conditions for grizzly bears, moving them away from areas of dense human population.

Alternative 5 would provide increased salmon habitat while retaining the wetlands habitat.

Under all action alternatives, interpretation of wildlife and black bear uses of riparian habitat, and safe wildlife/bear/human interactions would be provided. Interpretation and improved sanitation conditions fits with Recovery Plan objectives. Grizzly bear habitat would not be modified,

no increased use would occur, and no increased roads or motorized trails would be a part of any alternatives. All alternatives are consistent with the Recovery Plan for the grizzly bears.

Mitigation measures would implement timing restrictions during the fawning period during the first year. In addition, riparian habitat within 100 feet of the stream would be retained or improved. Noxious weeds would be reduced in operations areas. The loss of wetlands would be mitigated both on-site and off-site, through habitat improvement and conservation easements. The wetland mitigations will reduce the cumulative effects from increased development in the Icicle Valley.

The Alternatives 2, 3, 4, 6 and 7 would have a "May affect, not likely to adversely affect" to grizzly bears. Alternatives 1 and 5 would have a "no effect" to grizzly bears.

Bald Eagle

Bald eagles are known to perch and forage along the waterways, riparian areas and forests within and adjacent to the planning area. The cottonwood trees and conifers lining the historic channel provide perching habitat. No nests are known within one mile of the project area, though there is a winter roost site less than one mile upstream from the project area. Currently, salmon are not readily available along the historic channel, as few get above the hatchery on Icicle Creek. The planning area lies within the recovery area for bald eagle and is part of the Pacific States Recovery Plan for bald eagle (USFWS, 1983).

Under all alternatives, perch and roost trees would be retained in the riparian habitats. Under Alternatives 2, 3, 6, and 7, indirect effect from the loss of wetland habitat and subsequent effect on wetland-associated species would occur, however this is not a critical aspect of bald eagle feeding needs.

There are no known bald eagle nesting, roosting, or wintering sites within the planning area. The wintering site less than one mile upstream from the project area is on National Forest system lands. Any action alternative would implement a timing restriction for winter roost sites, reducing the possibility for a direct effect on this species.

Foraging habitat would be improved with all action alternatives, as an interrelated effect of increasing salmon in upper Icicle Creek. This would improve conditions for bald eagles by reducing the cumulative effects from loss of habitat (off site) on rivers in the area. A known winter roost area is above the hatchery now; increased fish populations can only improve those conditions.

All alternatives are consistent with Bald Eagle Recovery Plan goals due to: retention of perching, roosting and nesting habitat; increased prey base fisheries, and protection critical nesting and winter roost sites.

All action alternatives would have a "May affect, not likely to adversely affect" to bald eagles.

Northern Spotted Owl

There is one active spotted owl site approximately two miles from the project area. Most of the Hatchery grounds are non-habitat for spotted owls. Some nesting/roosting/ foraging habitat remains near the forested portion of the historic river channel to the south. Northern spotted owl surveys were conducted to protocol in habitat within one-mile of the project area, no spotted owls were detected. The forested lands adjacent to the historic channel provides connectivity for spotted owls moving across the landscape from the Swuak Late Successional Reserve (LSR) to the Icicle LSR and Deadhorse LSR.

Under all alternatives there would be no disturbance to any known spotted owl nesting. According to recent surveys, there are no spotted owls nesting within several miles of the planning area. Since the 1994 Rat Creek fire, nearby spotted owl activity centers have been abandoned, and the surrounding fragmented landscape is now occupied by barred owls and great horned owls. Noise disturbance, adjacent to surveyed spotted owl habitat, would occur after July 31st of the first year of operations, for each action alternative.

No alternatives would affect nesting, roosting, foraging habitat for spotted owls, there are no activities planned to occur in nesting/roosting/foraging habitat. No alternatives would affect dispersal habitat, there are no activities planned to occur in dispersal habitat.

All action alternatives would have a "May affect, not likely to adversely affect" to northern spotted owls.

Unique Habitats and Other Wildlife Species of Special Interest

Unique habitats are those present on the landscape, which provide diverse vegetative or geologic attributes, contributing to the viability of wildlife species. These habitats include open water. wetlands, riparian areas, deciduous forests, late-successional forests, habitat connectivity, snags, downed woody material, cliffs, rock outcrops, talus, meadows, and shrub fields. Several other wildlife species associated with these unique habitats are analyzed for effects from actions on federal lands. These species and habitats are discussed below.

Open Water, Wetland, and Riparian Habitats

From a landscape scale, the hatchery area provides a unique riverine and wetlands environment, due to the amount of open water in relation to the adjacent uplands of drier forest-type (ponderosa pine and Douglas-fir) and arid

shrub/forbs species (Ceanothus, bitterbrush and balsamroot). Most of the wetlands along the historic channel have developed since 1938, when hatchery operations rerouted much of the river, leaving a lower and slower water flow. Currently, riparian habitat within 100 feet of the historic channel has less large woody debris on the west side than on the east side. The riparian habitats in the planning area provide adequate to high quality habitat for many wildlife species guilds. The open water, wetland, and riparian habitats are very important in this lower part of the Icicle Valley, due to the juxtaposition of relatively undisturbed riparian and wetlands adjacent next to a high amount of human developments in riparian and wetlands (as the river flows downstream from the hatchery lands).

Alternatives 2, 3, 6 and 7 would result in a loss of wetland habitat in the historic channel. Alternatives 2 and 6 would allow the wetland to be naturally scoured by increased water flow, Alternative 3 would require dredging the historic channel to reduce downstream sedimentation. Alternative 7 would have a combination of natural scour from increased flows with some dredging to minimize downstream sedimentation. Of all the wetlands disturbance alternatives, Alternative 7 could cause the least amount of wetlands losses, because the habitat changes could be controlled. Alternative 5 maintains the most wetlands, because it does not require dredging of the wetlands or increasing flows that would cause natural scouring. Alternatives 1 and 5 would have the least affect to wetlands, open waters and riparian habitat.

Mitigation measures would balance direct effects. Mitigation for lost wetland habitats could include the creation of wetlands on-site at the canal and/or "return-flow-ditch". Creating wetlands on-site is preferred for replacing lost wetlands. Replacement of wetlands

would provide for breeding/foraging habitat for displaced Cascades frog, songbirds, waterfowl, bats, deer and elk, and other riparian or wetland-associated/dependent species. Offsite mitigations could include acquisition or Conservation Easements of off-site wetlands. This would also enhance or improve nesting habitat for wetland dependant species. See Appendix H-6 "Potential Wetland Mitigation Sites" for locations of possible quality wetland habitats in the Icicle and Wenatchee drainages.

Mitigation for all action alternatives would reduce disturbance from noise and to habitats in open water, wetland and riparian dependant species by beginning operations after July 31st of the first year of operations. Operations would continue through to the next breeding season, thus reducing establishment of nesting/breeding during restoration activities. Wildlife species may be temporarily displaced during the restoration period.

All action alternatives would promote long-term integrity of the native coniferous, deciduous, shrub and wetlands species. Green trees would be retained for future snags within the riparian habitat. Felled trees within riparian habitat would be retained as downed woody debris. Disturbed riparian habitat would be revegetated.

Aquatic Mammals

Beaver, river otter and mink inhabit the riverine systems. Beaver would be trapped and moved before the July 31st start of activities for alternatives that dredge or flush out the area of beaver dams. Beaver habitat would be revegetated with deciduous trees and shrubs, for future use by this species. Partially submerged downed wood and boulder material would be introduced into the stream corridor to function as loafing sites and habitat for aquatic wildlife species.

Alternatives 2, 3, 6 and 7 would result in a loss of wetland habitat in the historic channel, one of the riverine habitats that beaver are known to use. Of all the wetlands disturbance alternatives, Alternative 7 would disturb the least beaver habitat. Alternative 5 disturbs the least beaver habitat, because it does not require dredging of the wetlands or increasing flows that would cause natural scouring. Alternatives 1 and 5 would have the least affect to beaver.

Bat Species

The planning area is within the range of many bat species and four species are known to occur here. These bats feed on insects over open water and lush riparian and deciduous vegetation along the old river channel.

Mitigation for all action alternatives would reduce disturbance from noise and to habitats for bats, by beginning operations after July 31st of the first year of operations. Operations would continue through to the next breeding season, thus reducing establishment of nesting/breeding during restoration activities. Bat species may be temporarily displaced during the restoration period.

Returning Icicle Creek to a more natural condition may have a minor effect on the bat's ability to forage, due to a reduction in wetland plants that may, in turn, reduce the amount of insect prey found over the channel. Impacts to any of these species are expected to be minor and should not result in a further need to list them. These species' viability would be maintained under all alternatives.

Waterfowl and Water-birds

Numerous waterfowl species occur in Icicle Creek, the historic channel, the canal, and the "return-flowditch. In addition, Icicle Creek is one of few waterways in the Leavenworth area where Harlequin ducks are known to nest. Harlequin breeding and brood rearing areas need sufficient screening from disturbance activities that are above ambient noise levels. A recommended screening buffer could be as far as ¼ mile distant, depending on vegetation and topography (USFS-WNF, 1999).

Alternative 2 would require the eventual removal of the Headgate. Construction noise and human activity during removal would be a disturbance to harlequin ducks if it occurs while they are present. Mitigation for all action alternatives would reduce disturbance from noise and to waterfowl and their habitats. by beginning operations after July 31st of the first year of operations. Operations would continue through to the next breeding season, thus reducing establishment of nesting/breeding during restoration activities. Waterfowl may be temporarily displaced during the restoration period.

Alternatives 2, 3, 6 and 7 would result in a loss of wetland habitat in the historic channel, but would increase the amount of open water; backwater areas are still presumed to occur. Currently, waterfowl rear young on ponds within the historic channel; this habitat would not be changed under Alternatives 1 or 5. Under any alternative, the viability of the species would be maintained. It is not expected that any alternative would cause a further need to list these species.

Songbirds and Neotropical Migratory Birds

Many bird species are attracted to the relative abundance of open waters, wetland vegetation riparian habitats, and upland forests of the project area. Mitigation for all action alternatives would reduce disturbance from noise and to habitats for breeding birds, by beginning operations after July 31st of the first year of operations. Operations would continue through to the next breeding season, thus reducing establishment of nesting/breeding during restoration activities. Breeding birds may be

temporarily displaced during the restoration period.

Alternatives 2, 3, 6 and 7 would result in a loss of wetland habitat in the historic channel, which could reduce the availability of songbird habitat. Under any alternative, the viability of these species would be maintained. It is not expected that any alternative would cause a further need to list these species.

Amphibians and Reptiles

Frogs, toads, snakes, and lizards are known to occur in the project area. Habitat for amphibians is most abundant in the wetlands and riparian zones of the historic river channel, as well as the "return-flow-ditch", and some micro-site wetlands. Reptile habitat includes rock and downed logs in the arid uplands habitat, as well as wetlands and slow moving river habitat.

Mitigation for all action alternatives would reduce disturbance to amphibians and their habitats by beginning operations after July 31st of the first year of operations. Operations would continue through to the next breeding season, thus reducing establishment of nesting/breeding during restoration activities. Amphibians may be temporarily displaced during the restoration period.

Alternatives 2, 3, 6 and 7 would allow more water to flow down the historic channel, increasing the likelihood of downstream sedimentation and/or scouring of existing wetlands. Dredging the channel per Alternatives 3 and 7 would directly impact amphibian species by physically removing them from the channel during dredging, and all four alternatives would indirectly impact amphibians by reducing available wetland habitats. Alternatives 1 and 5 are the best alternatives for amphibians. Under any alternative, the viability of the species would be maintained. It is not expected that any alternative would cause a further need to list these species.

Mollusks

Habitat for terrestrial mollusks species is found in the planning area. The Chelan Mountainsnail has habitat in the dry ponderosa pine/Douglas-fir/oceanspray forests in the uplands around the hatchery grounds. The wetter riparian forest habitat has habitat for sideband snails, papillose tail-dropper. Down stream in the lower Wenatchee River and Columbia River there is habitat for aquatic mollusks that are sensitive to siltation and chemical toxins, these are fresh water mussels, and possibly California floater mussel, and Columbia pebblesnail.

Western river pearl mussel (Margaritifera falcata) parasitize mainly juvenile chinook salmon and rainbow trout during an early (larval) life stage called glochidia. Because of their dependence on fish to complete development, these mussels are also an indicator of fish presence or absence. Siltation, pH and dissolved oxygen levels, shading, instream habitat complexity, and water depth, velocity, and temperature are all factors in recruitment and survival (Stock, 1996). The most sensitive period for this mussel is mid-May to late-June.

Alternatives 2, 3, 6, and 7 would allow more water to flow down the historic channel, increasing the likelihood of downstream sedimentation. Increasing downstream sediments could impact many of the mollusk species, including the California floater mussel, Columbia pebblesnail, and Western river pearl mussel. Dredging the channel per Alternatives 3 and 7 would have less impact on mollusk species downstream, by physically removing the silt from the channel by dredging. Impacts, if any, to terrestrial mollusks are expected to be minimal under any of the alternatives. Under any alternative, the viability of these species would be maintained. It is not expected that any alternative would cause a further need to list these species.

Deciduous Forests, Late-Successional Forests, Habitat Connectivity, Snags and Downed Woody Material

This portion of the Icicle Valley has a blend of coniferous woodlands of Douglas-fir, western redcedar, grand fir and ponderosa pine, as well as deciduous tree species of cottonwood and aspen; the best habitat being along the east side of the historic channel. Large older ponderosa pine and Douglas-fir trees are currently scattered across the project area. This habitat connects private land and National Forest system lands. From a landscape view, the riparian forest in the hatchery project provides important connectivity within the Icicle watershed.

On the hatchery grounds snag habitat is limited, along the historic channel this habitat is more available, and south into the 1994 burn, snag habitat becomes more abundant. Downed logs are limited on the hatchery grounds, but more abundant in the historic channel area. The canal and the "returnflow-ditch" have limited available downed log habitat.

Mitigation for all action alternatives would reduce disturbance from noise to species moving through the area, by beginning operations after July 31st of the first year of operations (outside of breeding and migration periods). No action alternatives would affect forested species, their habitat, or connectivity between habitats.

Cavity Excavators and Associated Wildlife

Cavity excavating birds found in the project area include a variety of woodpeckers northern flicker, rednaped sapsucker, downy woodpecker, and pileated woodpecker. Other wildlife species that use excavated holes, as well as natural cavities for their nests include songbirds, waterfowl, owls, bat, and squirrels.

Snag and downed log levels would be maintained under all alternatives. Green-trees would be retained for snag recruitment. If trees need to be felled due to a safety risk, logs would be left on site to meet downed woody debris objectives. Under any alternative, the viability of associated species would be maintained. It is not expected that any alternative would cause a further need to list any of these species.

Forest Carnivores

Forest carnivores such as wolverine and fisher may pass through the area, but the planning area does not contain suitable habitat for these species. No impacts to wolverine or fisher are anticipated under any alternative. There are no known occurrences of these species within the planning area. No loss of forested lands adjacent to the historic channel is expected by any of the project alternatives, and habitat connectivity is not expected to be reduced. Under any alternative, the viability of the species would be maintained. It is not expected that any alternative would cause a further need to list these species.

Cliffs, Rock Outcrops, and Talus Habitat

The project area is within the valley bottom of the lower Icicle Valley, where terrain is limited to flat terraces. The project area also has very little natural meadow habitat, due to the amount of past disturbance and excavation of the hatchery grounds. Diffuse knapweed has become well in this area. There would be no effect to cliffs, rock outcrops, or talus under any alternative. The action alternatives would decrease noxious weed conditions, and improve shrubsteppe and meadow habitats.

Raptors

The planning area has foraging/roosting/perching habitat for a variety of owls and hawks. although no nest sites have been observed in the planning area. Mitigation for all action alternatives would reduce disturbance from noise to raptor species moving through the area, by beginning operations after July 31st of the first year of operations (outside of breeding and migration periods). No impacts to raptors are anticipated under any alternatives. Under any alternative, the viability of the species would be maintained. It is not expected that any alternative would cause a further need to list these species.

Peregrine Falcon

Two nesting pairs of peregrine falcons have been observed in Tumwater Canyon, several miles away. The LNFH grounds provide foraging habitat (waterfowl and songbirds) for falcons. The planning area does not have potential eyrie habitat (WDFW, 1996). The foraging habitat and nearby eyries contributes to the recovery of the species.

There would not be any direct or indirect effect to nesting as a result of any alternatives. No alternatives would affect cliff habitat for peregrine falcon. Because the known eyries are several miles from the planning area, it is unlikely that the restoration strategy would cause disturbance to peregrine falcon nesting sites. Timing restrictions are in place, should unforeseen offsite actions be necessary.

The wetlands provide habitat for peregrine falcon prey, which are songbirds and waterfowl. Under Alternatives 2, 3, 6 and 7, increased open water will provide a different habitat, but would still provide a prey base for peregrine falcon. This changed condition would have an indirect effect on peregrine falcon due to the reduction of available wetland habitat for songbirds. This would be balanced by the increase of river habitat for waterfowl and on-

or off-site wetland mitigation. Currently, songbird foraging occurs in the wetlands, and waterfowl rear young on ponds within the historic channel. Under Alternatives 2, 3, 6 and 7, waterfowl would experience a minor change, as open water would be more readily provided, while backwater areas are still presumed to occur. Songbirds and waterfowl would not experience an effect under Alternatives 1 or 5.

All alternatives are consistent with the peregrine falcon Recovery Plan, in that no activities would be allowed near the nest eyries during breeding season, river habitat would be restored, and loss of wetland (prey) habitat would be mitigated.

Issue # 14 - Community Impacts

The Leavenworth area is dependent upon tourism for economic activity. The community presents a village environment in a natural setting. Alternatives that restore "natural" conditions and/or preserve historical structures for interpretation fit well with tourist expectations for the community. Those alternatives that meet this goal would enhance economic opportunities for the community.

Alternatives 3, 4, 5 and 6 provide no additional recreational opportunities as compared to the No Action Alternative. Therefore, there are no expenditures to generate additional local economic activity. Alternatives 2 and 7 would create an additional fishery along the historic channel during the spring chinook season. The expected public demand for this fishery could result in a limited access program on the island. It is estimated that fishery access would be limited to 25 fishers/day over a six-week period. This would generate additional local economic activities. It was estimated that each sport fisherman spends \$43.13/day, in a comprehensive survey of Oregon Sport Fisherman (The Research Group, 1991). This

results in expenditures of \$42,286.50 for the six week fishing season. This level of expenditure would probably result in less than one new job created in the Leavenworth area. If anglers were not limited on the historic channel, it is estimated that 50-75 per day could be expected.

The restoration activities (basically construction using heavy equipment) would have a much greater impact on the local economy. This is somewhat more difficult to estimate since it is dependent on the type of equipment used, and who the successful bidders are on the contracts. It is expected, however, that some of the benefit would go to the Wenatchee Valley since more contractors operate from there and some would be successful bidders on the restoration. There would be a much greater beneficial effect on the community than the expenditures associated with the spring fishery.

Issue # 15 - Economics

This issue compares the cost of restoring fish passage above the LNFH and providing a natural riverine habitat with the economic benefits provided through such restoration. Economic efficiency is an inappropriate decision criteria when it comes to restoration of threatened and endangered habitat. The decision to recover threatened and endangered species presumes that the benefits to society are greater than the costs. The goal of species recovery is very rarely economic. Species recovery results in few quantifiable economic benefits. Therefore economic benefits of endangered species recovery are difficult to impossible to quantify accurately.

Existence values are the benefits received from simply knowing that the resource exists even if no use is made of it. Threatened and endangered species recovery is one of these important values. People are willing to pay for protection and restoration of resources that they

will never use. Unfortunately it is very difficult to quantify these values. But as discussed above, these existence values are very important and are expressed in the laws that Congress passes.

The primary economic benefits of the project are additional recreational opportunities. Alternatives 1, 3, 5 and 6 maintain a blockage at the spillway pool during the spring chinook run, therefore provide no additional recreation opportunities. The returning fish come during high flows when there is little opportunity for viewing fish, nor would there be any additional stream length open for fishing during any spring chinook open seasons.

Under Alternatives 2 and 7 there could be additional stream length open for fishing during the current spring chinook fishery. The current spring chinook fishery is popular, but the lack of public access limits the fishery largely to individuals that have access to private land along Icicle Creek or have boats that can handle the high spring flows. Alternatives 2 and 7, by removing barriers to spring chinook above the spillway pool, would create an additional fishery along the historic channel on public land. The very high demand for this fishery could result in a limited access fishery within the hatchery grounds. It is estimated that the fishing access would be limited to 25 fishers/day over a six week season. Willingness to Pay values for the anglers in

Central Idaho indicate values per trip of \$37.68 (McKean, 1999). These benefits would be \$39,564 for the season. If the number of fishers was not limited, two to three times these levels could be expected. This compares with the costs of \$6,020,209 for Alternative 2 and \$4,718,684 for Alternative 7. As can be seen by comparing the numbers the benefits do not begin to even cover costs.

However, as noted the reason for threatened and endangered species recovery is rarely economic.

The following table displays Construction Costs* of each alternative.

Table 4.5 - Construction

Alternative	Construction Costs
	\$0
2	\$6,020,209
3	\$5,697,069
5	\$1,738,623
6	\$4,547,696
7	\$4,718,684

^{*} A summary of construction costs for the Alternatives is provided in Appendix M. Construction costs were estimated in fiscal year 2000 dollars and include a construction contingency of 25%, mobilization and demobilization of 10%, and general contractor's overhead and profit of 15% for a total construction markup factor of 158%. Total project costs reported would also account for administrative and professional services with a planning and engineering markup of 12% and construction management markup of 12%. The total project cost markup, which would include the total construction markup, was therefore 196%.

Issue # 16 – Recreation/Education On Hatchery Grounds

Important Interactions

Current public uses occurring within the Icicle Creek planning area site include wildlife viewing, bird watching, and nature photography, by way of the Icicle Creek Interpretive Trail, a one mile loop nature trail for foot traffic only. This trail is self-guided and incorporates a historical theme of hatchery operations that provides some interpretation of the old rearing structures. The trail follows Icicle Creek for 1/2 mile and winds its way back to the paved hatchery road system. Other public recreational uses in the planning area are seasonal, by nature. A winter crosscountry ski trail and snowshoe trail follows the hatchery road system and is managed by the Icicle Winter Sports Club on a Special Use Permit. A summertime Special Use Permit is also issued to permittee. Icicle Outfitters, and allows June -September guided horseback rides along the same system. No motorized vehicles or off-road vehicle use is allowed on the island area. Hunting and fishing is prohibited.

The planning area is utilized for guided interactive activities during the Wenatchee River Salmon Festival, held in September each year. During the tribal fishing season, guided hatchery tours also include a walk to the overlook on the canal bridge to observe traditional tribal fishing in the hole at the bottom of the spillway. Fishing platforms being used by tribal anglers is a very interesting interpretive site for hatchery visitors.

Environmental Effects

Alternative 1

Recreational and educational activities would proceed as described in Chapter 3.

Alternatives 2, 3, 6 and 7

Heavy equipment and related construction traffic would utilize the spillway bridge for access to the island and most roads on the island that the public uses for hiking, riding and skiing. During heavy construction periods after July 15, the island would be closed to the public, due to safety considerations. If construction was at a low level, perhaps at one location on the island, only that portion of the island would need to be restricted. Restrictions would last from 6–10 months during the year of construction activities.

Hikers, riders and skiers that utilize the island for recreational purposes would need to go elsewhere in the valley for these pursuits.

Educational programs such as the Salmon Festival and the Discovery High School that utilize the island would similarly be restricted from the island. Alternative areas suitable for these programs are limited.

Piles of dredged sediment on the island under Alternatives 3 and 7 would provide additional terrain relief, which would provide more varied terrain for the winter cross country skiing trail network.

Alternative 5

Construction of the new fishway from the holding ponds to the canal would block access to the spillway bridge. This closure would likely last 6-9 months from July 31 during the year of construction activities. All recreational and educational use of the island would be restricted while construction occurs. After implementation additional educational experiences would be available, as visitors could watch

non-Hatchery fish be separated and sent up the new fishway.

Effects Common to All Action Alternatives

Restoring fish passage at the Leavenworth Fish Hatchery would not have any negative recreational effects on public use of the island area except during the project construction phase.

All education and interpretation programs of the hatchery would only be enhanced by the increased potential of teaching about habitat restoration, endangered species, flora and fauna identification, salmon biology, hatchery history, and more. The Icicle Creek trail brochure would need updating and additional historical interpretation built in to the walking tour for all alternatives proposed except Alternative 1.

The presence of threatened and endangered anadromous fish in the project site would affect plans for construction of any new visitor facilities on the site and expansion of the Icicle Creek Interpretive trail. At this time, there are no such plans under consideration. Fish and wildlife viewing opportunities would need to be carefully monitored so as not to encourage harassment or take of any listed fish species.

Issue # 17 – Recreation On The National Forest

Environmental Effects to All Action Alternatives

The effects of all action alternatives would be the same. The presence of threatened and endangered anadromous fish in the upper river has the potential to affect all recreational use and facilities in the Icicle. However, the presence of these fish is not dependent on removal of the physical barriers at the LNFH since there is currently a potential for the presence of

anadromous fish in the upper Icicle regardless of the alternative. The current presence of threatened and endangered fish (including bull trout) in the upper river could have implications in regards to recreation use, new facilities, and even existing facilities. Effects could range from no change in existing uses and facilities to restriction or closure of many recreation activities and facilities. However, there is a rockfall barrier just above Snow Creek that may block most of these fish from proceeding further upstream.

Existing facilities and the major uses that are currently occurring in the Icicle drainage are listed in Chapter 3. These facilities or uses could be considered to pose a threat to any threatened and endangered fish runs that are being established in the upper Icicle. At some point in the future it might be determined that the such uses or facilities need to be curtailed or eliminated.

No action to limit current recreation in the Icicle is suggested in any of the project alternatives at this time. Actions taken or proposed in other situations in the Western United States give an idea of the kinds and range of actions that could possibly occur in the Icicle. These actions could include:

- Closure of the Icicle and its tributaries to all recreational fishing.
- Closure of campgrounds adjacent to the Icicle River.
- Closure or use restriction on some trails.
- Closure or restriction of some recreational activities in the Icicle, especially close to Creek sides.
- Increased level of road maintenance to reduce erosion.

It should be noted that none of these closures or restrictions are being suggested at this time.

Issue # 18 – Access to Private Property Across Channel

There is currently a private residence located at the extreme southeast corner of the planning area. It is located on private property southeast of the headgate, Structure No. 2, and is accessed by vehicle and foot traffic across bridges located on top of Structures No. 2 and 5. Unlimited access to this private residence, only, is guaranteed by Warrantee Deed Number 305227 as set forth in Book 270 of Deeds, at pages 445-447, of the records of Chelan County, Washington signed and dated December 5, 1939.

Alternative 1: No Action

Both the original channel and Icicle canal would be managed as they presently are. Under this alternative, there would be no change in access to private property.

Alternative 2: Remove all Structures and Natural Flushing of Sediments

This alternative would remove all of the structures in the historic channel and rely on natural flushing to remove sediment from the channel. After the channel has been restored, in 10 – 15 years, Structure No. 2 would be removed and the canal would be blocked. The head end of the canal would be modified so that all river water would be re-directed into the original Icicle Creek channel.

The loss of Structure No. 2 would require the construction of a vehicle bridge to allow access to private property. That bridge would be located upstream of the headgate (Structure No. 2). Of the 3 existing bridges, only the one spanning the spillway would remain. While this would continue to provide hatchery access to the interpretive trails and displays located on the island formed by the original Icicle Creek channel

and the manmade canal, there would be no other ingress or egress sites.

Alternative 3: Removal of Most Structures and Mechanical Dredging of Sediments

This alternative would restore the historic channel while partially retaining two structures: Structure No. 2 would be retained in its entirety (including two rack structures below the headgate) as both a flow control structure and a representative display of the historic structures originally constructed at the hatchery. Structure No. 5 would be modified so that it can be operated as a seasonal barrier, which is able to pass sediment, but block fish passage. When the barrier is active during spring chinook salmon returns, fish passage would be provided by a new fish ladder around the structure.

Since the headgate and Structure No. 5 would be retained, there would be no effect on vehicle or pedestrian access to private property. The bridges, which currently exist on these structures, would also be retained.

Alternative 5: Fish Ladder Bypassing the Spillway

Structures No. 2 and 5 would be retained along with their associated bridges. This alternative would have no effect on vehicular or pedestrian traffic to private property located southeast of the headgate.

Alternative 6: Modify the Headgate and Structure No. 5 Only and Natural Flushing of Sediments

Since all structures would remain (although modified) along with their associated bridges, this alternative would have no effect on vehicular or pedestrian traffic to private property located southeast of the headgate.

Alternative 7: Historical Preservation of Structure No. 4 and Natural Flushing and Mechanical Dredging of Sediments

This alternative would remove most historic structures while using both mechanical dredging and natural flushing to remove accumulated sediment. The headgate at Structure No. 2 would be rehabilitated and operated as a flow control structure. The remaining portions of Structures No. 2 and 3 would be removed. Structure No. 4 would be restored and maintained with its associated pedestrian bridge as a representative display of the historic structures originally constructed at the hatchery. The existing Structure No. 5 would be demolished and removed.

With the removal/demolishment of Structure No. 5 with its associated vehicle bridge, access to private property would be provided using the bridge spanning the spillway.

Specifically Required Disclosures

None of the alternatives would have an impact upon women, minority groups or the civil rights of any United States citizen. Native Americans, having established historical uses for subsistence or religious purposes have been consulted as part of this process.

None of the alternatives would have any direct impacts upon prime farmlands or rangelands.

Environmental justice is achieved when everyone, regardless of race, culture or income, enjoys the same degree of protection from environmental and health hazards and equal access to a healthy environment to live, work and play. Minority or poor communities adjacent to the LFNH include Hispanics and American Indians.

Many Hispanics in the area hold lower paying jobs in the service and agricultural industries. Many American Indians have a rural lifestyle that is reliant on a clean and healthy environment. The LNFH offers sites that have religious or spiritual meaning to some American Indian tribes.

Scoping for the project was through public notices, letters to known interests and personal contacts with representatives of American Indian tribes.

The effects that any of the action alternatives would have on American Indians are described in detail in this EIS. The effects that any of the action alternatives would have on the Hispanic community are indirect and low-level. Additional employment would be created for the action alternatives both in the construction and operational phases.

There are no environmental health risks or safety risks specific to children. During construction phases, all recreationists would be restricted from the island. Resultant structures left in the channel would be better maintained than the current situation.

There is no identified conflict in any of the alternatives with the land use of any federal, state or local entity.

Irreversible effects of Alternatives 2, 3, 6 and 7 concern the removal of historic structures. These Structures are a non-renewable resource. However, a plan to mitigate for this loss is included as part of these alternatives.

Irretrievable effects of Alternatives 2, 3, 6 and 7 concern the conversion of wetland to riverine habitat. These wetlands are a renewable resource and the mitigation plan which is a part of these alternatives replaces this lost wetland habitat.

Chapter 5. List of Preparers

5.1 Interdisciplinary Team

Name

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5.2 Technical Assistance

Name

Sverdrup Civil, Inc.
ENSR
Kate Terrell, U. S. Fish & Wildlife Service
Katherine March, WA. DOE
Janet Millard, U.S. Forest Service
Julie A. Smith, U.S. Fish & Wildlife Service

5.3 Management Oversight

Name

Greg Pratschner, U.S. Fish & Wildlife Service Chuck Dunn, U.S. Fish & Wildlife Service

Area of Expertise

NEPA Specialist Fish Biologist Hydrology Engineering Public Information & Education Archaeology/Historian Wildlife Biologist Wildlife Biologist Fish Biologist Botanist Hydrology Botanist Recreation Economist Tribal Fishery **Hatchery Operations Hatchery Operations**

Area of Expertise

Engineering Hydrology Ecological Services/Permitting Wetlands-Habitat Biologist Wildlife Editor

Area of Expertise

Leavenworth Complex Manager FWS Regional Office-Region 1 Chapter 6.
Persons,
Organizations
and Agencies
Participating
and/or
Responding

Public information on this project began in March of 1999 with the first public meeting held at the Icicle River Middle School in Leavenworth, Washington. A second public meeting was held in July of 1999. Frequent information updates were made available through the Leavenworth National Fish Hatchery website and an aerial video documentary of the project area was produced for public review. Several informational presentations were made to community service clubs, irrigation districts, schools, and agencies from summer 1999 to spring 2001.A portable traveling exhibit depicting the history of the fish hatchery and project information was displayed at the Wenatchee River Salmon Festival and at the official public meetings. A project contact logbook was created and maintained daily when questions or comments were received by members of the interdisciplinary team or hatchery staff.

All responses, questions, comments from the public meetings, presentations, and miscellaneous calls were sorted into categories of interest and issues. This analysis summarized public concerns and opinions and helped the planning team in the process of determining key issues of the entire project. The public comment log book is on file and continues to be updated at the Leavenworth National Fish Hatchery Information and Education manager's office.

Copies of the Draft Environmental Impact Statement (DEIS) were distributed to the following individuals, organizations and government agencies. Copies of the DEIS are also available for review at the following locations:

Leavenworth National Fish Hatchery 12790 Fish Hatchery Road Leavenworth, WA 98826 509/548-7641 Leavenworth Ranger District 600 Sherbourne Leavenworth, WA 98826 509/548-6977

Government Agencies

Bureau of Reclamation Yakama Indian Nation Colville Confederated Tribes U.S. Fish and Wildlife Service U. S. Forest Service U. S. Environmental Protection National Marine Fisheries Service Washington State Department of Fish & Wildlife City of Leavenworth U. S. Department of Interior Leavenworth Public Library Dept. of Ecology Bonneville Power Administration Chelan County P.U.D. Governor's Salmon Recovery Office (Washington) Chelan County Sheriff Columbia Inter-Tribal Fish Commission Chelan-Douglas Health District Chelan County Commissioners Chelan County Planning Commission Natural Resources Conservation Service Bureau of Land Management U. S. Army Corps of Engineers U.S.D.I.-Bureau of Indian Affairs USFWS Eastern Ecological Services

Organizations

Northwest Ecosystem Alliance
NW Steelhead and Salmon Council
Northwest Power Planning Council
NCW Audubon
Washington State University
Natural Resource Sciences
Cascade Irrigation District
Icicle Creek Watershed Council
Trout Unlimited
Icicle Irrigation District
Icicle Outfitters and Guide Service
Washington Trout
American Rivers
Clearwater Bio Studies

Leavenworth Chamber of Commerce Leavenworth Winter Sports Club Leavenworth Summer Theatre Pacific Rivers Council Seattle Audubon Society Rivers Council of Washington Sierra Club-NW Office Steelhead Trout Club of WA Washington Native Plant Society

Individuals and Private Businesses

Senator Linda Evans-Parlette Harriet Bullitt Dick Rieman Mike Nykreim John St. Pierre Joel Teelev Chuck Huntington Ron and Jan Captenter Anne Nowacki Arlene Blackburn **Buford Howell** Greg and Sharon Lunz NW Flyfishing, Luke Brown Carl and Sheila Bergren A. Doug Allen Carl Babiar Kiell Bakke Pamela Trudeaux Alfred Bergren Rob Newsome Blue Dun Fly Shop D.R. Buddinton Gretchen Daiber Pack and Paddle Outdoor Connection C.C. Pittack Rudy Prey Chris Rader Ron and Cheryl Riggs Harold Riise Eric Root Joseph Roy Delbert Schmidt Rod Darlington Ted Smith Lou Wagoner Dick Whitney Rolf Wielick **David Winters** Joseph and Cheryl Wood Kent Watson Kathi Zehner Der Sportsman Ivan Dinwiddie

Werner Janssen
George Lang
Robert Stroup
Lyman and Janeane Boyd
Tom McKindley
Lisi Ott
David Pflugrath

Glossary

Alternate Pond Management Strategy – Involves rearing fish in different ponds at different times or re-using water.

Aquifer - A water bearing stratum of permeable rock, sand or gravel.

Bedload – The part of a stream's load that is moved on or immediately above the stream bed, such as the larger and heavier particles (boulders, pebbles, gravel) rolled along the bottom; the part of the load that is not continuously in suspension or solution.

Canal/Bypass Canal/Icicle Canal - Different terms for the man-made canal above the spillway.

Channel, Old - The historic channel.

Channel Morphology - Form and structure of a channel.

cfs - A measure of water flow, cubic feet per second.

Cone of Depression – A depression in the potentiometric surface of a body of ground water, which has the shape of an inverted cone and develops around a well from which water is being withdrawn.

dps - Distinct population segments.

Endangered Species – Plant or animal species likely to become extinct throughout all or a significant portion of its range within the foreseeable future.

ESA - Endangered Species Act.

ESU - Evolutionarily significant unit.

Evolutionarily Significant Unit (ESU) – A population that is reproductively isolated from other conspecific population units, and represents an important component in the evolutionary legacy of the species.

Glaciofluvial - Pertaining to meltwater streams flowing from glaciers or to the deposits made by such streams.

Headgate - The upper portion of Structure No. 2, which regulates the amount of stream flow into the old channel.

HDPE - High Density PolyEthylene.

Historic Channel/Original Channel/Natural Channel/Icicle Channel – Different terms for the reach of the Icicle with structures in it.

ID Team - Interdisciplinary Team, the team of resource specialists that conducted this analysis.

Interior Columbia Basin Ecosystem Management Project (ICBEMP) – The ICBEMP was established by the Eastside Ecosystem Management Project Charter in January 1994 to develop specific products that would lead to the adoption of a scientifically sound, ecosystem-based strategy for managing FS- or BLM-administered lands within the Basin.

Island, The - The land area between the canal and the old channel.

Iteroparous - Able to spawn more than one time; reproducing annually, or having more than one brood.

Late-Successional Reserve – Land allocation under the NWFP with the objective to protect and enhance conditions of late-successional and old-growth forest ecosystems that serve as habitat for late-successional and old-growth forest related species.

LNFH - Leavenworth National Fish Hatchery.

Managed Late-Successional Area – Land allocation under the NWFP; similar to LSR, but identified for certain owl territories in the drier provinces where regular and frequent fire is a natural part of the ecosystem.

Meander Loop - A U-shaped bend in a river, also referred to as an oxbow.

MCRFRO - Mid-Columbia River Fishery Resource Office.

Northwest Forest Plan (NWFP) – Coordinated ecosystem management direction incorporated into land management plans for lands administered by the Bureau of Land Management and the Forest Service within the range of the northern spotted owl.

Planning Area/Project Area - Different terms used interchangeably for the area where actions are proposed.

Protection Buffer – Standards and guidelines for specific rare and locally endemic species, and other species in the upland forest matrix, in the NWFP standards and guidelines.

Regional Forester's Sensitive Animal List – Those species identified by a Regional Forester for which population viability is a concern.

Riparian Reserve – Areas along live and intermittent streams, wetlands, ponds, lakes, and unstable and potentially unstable areas where riparian-dependent resources receive primary emphasis.

Sensitive Species – Those species that: (1) have appeared in the Federal Register as proposed for classification and are under consideration for official listing as endangered or threatened species; (2) are on an official state list; or, (3) are recognized by the implementing agencies as needing special management to prevent their being placed on federal or state lists.

Species of Concern (SC) – Species of Concern is an informal term that refers to those species which the USFWS believes might be in need of concentrated conservation actions. Such conservation actions vary depending on the health of the populations and degree and types of threats. Species of concern receive no legal protection and the use of the term does not necessarily mean that the species will eventually be proposed for listing as a threatened or endangered species.

SHPO - State Historic Preservation Office.

Structure - As in "Structure" No. 2 refers to each in-stream structure, which could include different components such as a dam, rack, or spillway. Refer to Appendix A for Structure locations.

Structure 2/Headgate – The headgate is the water control device which allows water into the historic channel. The headgate is a part of Structure 2.

Survey And Manage – Mitigation measure adopted as a standard and guideline within the NWFP Record of Decision that is intended to mitigate impacts of land management efforts on those species that are closely associated with late-successional or old-growth forests whose long-term persistence is a concern.

TES/ETS - Threatened, Endangered and Sensitive Species.

Thalweg - A line connecting the lowest points along a streambed or a valley. Also known as a valley line.

Threatened Species – Plant or animal species likely to become endangered throughout all or a significant portion of its range within the foreseeable future.

Transmissivity – The rate at which water of prevailing kinematic viscosity is transmitted through a unit width of an aquifer under a unit hydraulic gradient.

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